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# THE PHILOSOPHY OF FLOWER SEASONS.[1]

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The researches of recent botany have more than once suggested the vague outlines of a truth that, though manifestly requiring investigation, has as yet received but little definite expression. It is:—the philosophy that underlies the association of certain groups and types of flowering plants with certain definite seasons of the year; the principles that will show how this association accords with the "eternal fitness of things."

The subject is of broadly interesting scope, but its treatment requires caution because of the variety of somewhat conflicting considerations involved. Obviously the aim cannot be to find any single absolute principle that will cover all cases, but rather to make some broad general observations that shall embrace all the diverse circumstances and at the same time express each with greatest definiteness. The field for investigation must be clearly presented and have its data determinable with certainty and completeness, and such can be found in the flora of the northern U. S., eastward from the Rockies. This has been more thoroughly studied than any other so large section of American flora, and is familiar to a large proportion of students.

[1] Condensed for THE AMERICAN NATURALIST from a more extended thesis on the subject.

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Taking this, then, as the field, here is the problem presenting itself:—From March to November each month brings a new prospect in field and forest, an edition of flower-life distinctively its own; and each edition seems thoroughly to harmonize with its own peculiar season. Each offers characteristic features, and every careful observer can feel in this succession of differing forms a harmony into which any decided change would break discordantly. To bring this more forcibly to the mind, conceive for a moment the existing series somewhat transposed: imagine the prairies brilliant with Solidago and dotted with the purple Aster in early May; Trillium adorning the woodlands in September; the vivid Lilium superbum and the flaming Asclepias tuberosa in the April meadows; Hepatica and Sanguinaria in mid-July; and Epigæa in late autumn. Entirely aside from the element of novelty, such a picture would be bewilderingly inharmonious, and its features out of tune with their position by virtue simply of their character,—in this there would be an appreciable and evident lack of fitness. To say that the fall flowers are not the spring flowers, or those of summer are neither, merely because they have chosen at random this season or that is neither science nor common sense. The truth is forced upon us that the various groups of flowering plants are not scattered indiscriminately from one end of the seasons to the other, but are regulated by definite systematic principles; and that just as relations can be traced between physical geography and geographical distribution, or between plant-history and geological periods, so is there a connection between the relations of season to season and the relations of their respective floras.

In this inquiry we see constantly the impossibility of drawing sharp lines of demarkation between successive groups of conditions; and, as in classification systems, so in serially arranging successive floras, it is impossible to follow a linear order. Also, exceptional instances are many, and hence, to reach conclusions that are broadly true, *predominant* types must be considered, though the unusual cases may be in themselves manifestly significant. Only a broad sweep of data can bring out a general connection between the multiplicity of con-

siderations. To this end it will be reasonable to consider the groups of flowering plants in the most strictly natural order of their evolutionary relationships, from the lowest up. That this evolutionary system is largely based on floral structure is suggestively apropos of our theme, but how far the intimacy of the connection may extend the further development of the discussion will reveal.

Passing to the outline of recorded observation we may discuss each condition of the problem as it arises. The three seasons considered have these limits:—spring; late March, April, May: summer; June, July, August: autumn; September and October. *All* statements *refer only* to the area about covered by Gray's Revised Manual: the U. S. north of Tennessee and eastward from west Kansas.

Of the two series of flowering plants, the Gymnospermæ and Angiospermæ modern botany concedes that the former, from their near approach to the higher Pteridophyta, represent the lower character of development, though the highly specialized Coniferæ may rise to a position nearly *parallel* to the highest Angiospermæ. The Coniferæ comprise all our indigenous Gymnospermæ;—and all flower in the spring from late March to earliest May, none in summer or autumn.

In the Angiospermæ, the Monocotyledons and Dicotyledons are two nearly parallel classes, the Monocotyls, though not transitional, representing, as a class, a lower character of development than the Dicotyls. Compare first the two classes in a general manner: The indigenous Dicotyls number much over twice the indigenous Monocotyls, and of the latter over half are in the great orders Cyperaceæ and Graminaceæ. And these orders demand special attention, for they together represent one of the most remarkable instances of high specialization in the whole census of plant-life. Apropos of this let us call to mind for further use the five characters of organic development which certain carefully systematic evolutionists have recognized:—*typical* forms, which present all the main characters of their group with fullest intensity; *generalized-normal* which have the normal characters somewhat poorly developed and defined; *specialized-normal*, which retain the

normal structure but with evident one-sided development of it; *generalized-aberrant,* which depart from the normal but drift toward several or many outside relationships; and *specialized-aberrant,* which go off on a distinct individual line of their own. The Cyperaeæ and Graminaceæ are *specialized-aberrant* Monocotyls; and as they depart from the rest of the Monocotyls in structure, so, in the main, does their blooming season stand apart. Though extending from May, it culminates, particularly with the Graminaceæ, in the late summer and early fall, and stretches on into October. With reference to all other Monocotyls, note that by far the majority,—typical, normal, and *generalized-aberrant,*—confine their blooming season to spring, or early summer, or mid-summer, though fewer in the last. But in late summer and autumn occur only a few isolated cases. Indeed, even in the Glumaceæ excepted in the last statements, the great predominant genus of Cyperaceæ, the genus Carex, including much over half the order, belongs strictly to May. On the other hand, the Dicotyls, the higher Angiospermæ, are spread straight through the seasons, from March to November, represented by forms of all characters,—typical, normal, and aberrant. Thus, excluding Graminaceæ and several genera of Cyperaceæ, the Dicotyls may be said to constitute almost the entire flora of late summer and of autumn.

The Spadicifloræ and Liliifloræ form two fairly distinct subclasses of Monocotyls, closely parallel and somewhat interrelated. Though a debatable question, the imperfect and reduced flowers so general in the Spadicifloræ rather justify the conclusion that these are of the lower order of development. Moreover, throughout this subclass diclinism predominates, while the Liliifloræ are generally both hermaphrodite and complete and with well-developed perianth.

Normal and typical Spadicifloræ are the Araceæ. All these flower in May or June, except Symplocarpus. That its odorous scapes push out of the swamp mud in April is presumably a provision to insure cross-fertilization of the inconspicuous, though strong-scented, spadices before they are hidden by the subsequent growth of the huge rank foliage. Later, through

the summer, flower the Typhaceæ, which, as *generalized-aberrant* Spadicifloræ, represent a rather more advanced degree of specialization than most Araceæ. Also in mid-summer come the remarkable little Lemnaceæ, usually considered a highly *specialized-aberrant* offshoot from Araceæ, though the connection is doubtful.

Among Liliifloræ the three apocarpal orders, Alismaceæ, Juncaginaceæ, and Naiadaceæ, form a remarkably aberrant group, of few species, but wide-spread, particularly Sagittaria and Alisma. All come in late summer, and some among the exceptional non-glumaceous Monocotyls of autumn. Potamogeton, in Naiadaceæ, numbers a good many species, and comes late; but note that the genus is one of the most peculiarly specialized.

All the Spadicifloræ and Apocarpal Liliifloræ are scarce a tenth of the remaining Monocotyls, the Syncarpal Liliifloræ. This division naturally subdivides into the Hypogynæ and Epigynæ, somewhat parallel and closely inter-related. In the light of our present knowledge of the morphology of the hypogynous and epigynous flower there can be no doubt that the Epigynæ here represent the higher order of development, although many Hypogynæ may rise to a more than equivalent degree of specialization,—precisely as the genus Felis is considered to represent a lower order of development but a higher degree of specialization than the anthropoid apes.

In the non-glumaceous Hypogynæ most prominent is the order Liliaceæ, in which are, pre-eminently, typical and normal forms. Among the normal, particularly the more generalized, the first bloom in late April,—notably, for instance, Erythronium, about the earliest of Monocotyls. Scarcely later come Trillium, Uvularia, Smilacina, Polygonatum, Maianthemum, and others. Other genera extend through May and early June, and a few, finally, belong to mid-summer. Certain of these last, as Allium and Smilax, are, though normal, markedly more specialized than the principal spring-flowering genera. But the mid-summer genus Lilium claims peculiar prominence as an ideally "*typical*" genus in all the term implies. *Lilium philadelphicum, L. catesbæi, L. canadense,*

and *L. superbum* stand together in the July meadows as the type of their order and of the Hypogynæ. Their high order of development and their blooming season has a significant bearing on our problem. The aquatic Pontederiaceæ and the ephemeral Commelinaceæ, both few in species, and the odd genera Aletris and Xyris, are of mid-summer. With Smilax comes the nearly-related Dioscorea. Markedly conspicuous mid-summer Hypogynæ, rather intermediate between Liliaceæ and Cyperaceæ, are the widespread and aberrant, glumaceous types, Juncaceæ. But even these are less highly specialized than the two great orders Cyperaceæ and Graminaceæ, comprising over half of all our Monocotyls. The Graminaceæ are unquestionably the more highly specialized, and as distinctly *aberrant*, among Liliifloræ, as are the Lilia *typical*. Their period of greatest predominance extends from mid-July well into October. In Cyperaceæ it is curious that over half the order, the great genus Carex, attains full perfection in May; while the *type*-genus Cyperus belongs to August and September, most other genera to mid-summer, and a few to June. But mark especially: all the summer and fall Cyperaceæ, save a very few, are hermaphrodite, while Carex is entirely unisexual. The significance of this will come up later.

The review of Monocotyls closes with the Epigynous Liliifloræ, a small group compared with the Hypogynæ, but peculiarly interesting. Of the *generalized-normal* order Amaryllidaceæ we have only one wide-spread species, the little Hypoxis, of early summer. Iris comes in the spring and Sisyrinchium a little later, both rather specialized genera. Finally, the crowning glory of its class is the highly specialized order Orchidaceæ. Late in May come the earliest forms,—Orchis, Arethusa, and Corallorhiza. In early June:—Pogonia, Liparis, Calopogon, Listera, several green Habenarias, and the splendid genus Cypripedium. The succession of species in this genus is instructive:—Earliest, in late May, comes the little white *C. candidum;* a little later the low stemless type with its large complicated flower, *C. acaule;* still later the small-flowered but tall-growing *C. parviflorum;* later yet, the large cousin of the last, *C. pubescens;* and latest, late in June, most

robust, vigorous, and conspicuous, the splendid *C. spectabile.* In late June and through July come other Pogonias and Corallorhizas; Microstylis, Goodyera, and one or two Spiranthes, and all the most beautiful Habenarias. Last, in September and October, singularly isolated from nearly all their kinsman, are several of the little Spiranthes,—why they come thus is a baffling question. Retrospectively we remark that of non-glumaceous Liliifloræ the two predominant orders are Liliaceæ and Orchidaceæ; that the first are largely normal and generalized, the second aberrant and specialized; and that the first predominate in the spring, the second in summer.

In the Dicotyls two quite distinct subclasses may be recognized: the one, the Diclinæ, is a very natural group, small but of great importance, embracing the closely related orders of trees and shrubs, Platanaceæ, Juglandaceæ, Cupuliferæ, and Salicaceæ; the other, vastly the larger, exhibits a broad, rather indefinite range of characters, and may be termed, in contra-distinction, the "Hermaphroditæ," because hermaphroditism, though by no means universal, predominates in it. The Diclinæ obviously approach the Coniferæ, among Gymnospermæ, in wood-structure and manner of growth, and in amentaceous diclinous inflorescence. Whence there is just reason to consider them, though wonderfully specialized, of a lower character of development than the Hermaphroditæ. Unisexual flowers, or the analogues of unisexual flowers, are the rule in Gymnospermæ and the higher Pteridophyta, and hence it reasonably follows that diclinous Angiospermæ are lower than hermaphrodite; and, further, diclinism in all Angiospermæ is either a perpetuation of the ancestral type or a reversion to it. In Diclinæ and in the Spadicifloral Monocotyls it is probably a perpetuation; in Carex, many Graminaceæ, and elsewhere among Angiospermæ, more likely reversion, retrogressive evolution. Note here the peculiar fact that in spring, from early March to June, blossom these diclinous groups:—all Coniferæ, the Araceæ, the great genus Carex, the Diclinæ, the Lauraceæ, several diclinous Ranunculaceæ, Urticaceæ, and many others; while in summer and fall come only:—a few Alismaceæ and Typhaceæ, many Graminaceæ,

the Euphorbiaceæ, some Urticaceæ, and a few other isolated cases, but altogether a comparatively small number,—especially so because the Graminaceæ mentioned rarely have spikes entirely of unisexual flowers and hence do not strictly fit the case. The diclinism occurring in many Compositæ is not referred to, because it is not analogous to diclinism in other plants, and the Compositæ are relegated to a category of their own by their highly specialized inflorescence;—their diclinous "capitum" is functionally equivalent to a single perfect flower in other Angiosperms. The blossoming of so many trees, especially the Diclinæ, in earliest spring, before leaf-budding, must evidently have at least partial connection with anemophilous cross-fertilization.

The Hermaphroditæ (this term only signifying a *predominant* character) parts naturally into the Choripetalæ and Sympetalæ, nearly parallel and somewhat inter-related. The first includes the Incompletæ (so-called Apetalæ), which cannot be naturally made a separate division. It is conceded now that the Sympetalæ are higher than the Choripetalæ, though the divisions are not successive, save in that the first probably rose from some aberrant form of the second. There are three clear sub-divisions of the Choripetalæ, partly serial and partly parallel,—Hypogynæ (including so-called Discifloræ), Perigynæ, and Epigynæ. The Epigynæ are past question the highest, and the Perigynæ rather intermediate.

Earliest of the Hypogynæ are the Ranunculaceæ, peculiarly normal and typical and distinctively spring-flowering, extending from mid-April to early June. Hepatica, Anemonella, Caltha, Ranunculus, Aquilegia,—all synonymous with spring. Note that the more specialized forms, such as Aquilegia, Delphinium, Aconitum, etc., are the later, and some Clematis belongs to summer. With this early order come also our Magnoliaceæ and Berberidaceæ; late in May the Dicentra and Corydalis; through May and June the particularly natural and normal order Cruciferæ, more specialized, however, than Ranunculaceæ. In April comes that wonderfully symmetrical and typical form of the Papaveraceæ, the Sanguinaria. Remarkably aberrant in habit, but rather generalized in floral

structure is the Sarracenia. It blossoms in latest May and early June. Among the earliest blossoms is the so abundant little normal type, Claytonia. Viola is a large, distinctive, and cosmopolitan genus, rather specialized-normal in character. Oddly enough it has species in bloom from April to October, some blossoming both spring and fall, besides producing cleistogamous flowers all summer. Yet even in so constantly present blossoms we easily recognize a period during which they reach by far their greatest abundance and perfection, viz.: May and June. Two unique orders belong to summer, Cistaceæ and Hypericaceæ, the second the later and remarkable particularly for its polyadelphous stamens. The incomplete flowered Urticaceæ belong mainly to summer, all save the group of spring-flowering shrubs and trees, Morus, Celtis, Planera, and Ulmus. All these are diclinous or polygamous, and Ulmus seems to possibly and probably connect its order with the Diclinæ,—like these it flowers in March and early April. Turning back to the near relatives of the Ranunculaceæ we find in mid-summer the aquatic genera Cabomba, Brasenia, Nymphæa, Nuphar, and Nelumbo, all *specialized-normal*, particularly Nelumbo, the latest to flower. The so-called Discifloral Hypogynæ rank somewhat above such typical forms as the Ranunculaceæ and Cruciferæ, and among them stand several important summer orders:—Caryophyllaceæ; Malvaceæ; the strange Euphorbiaceæ of July, August, and September; and the Geraniaceæ, of which the aberrant Impatiens is latest. Anacardiaceæ belong to June. But the two tree-families, Tiliaceæ and Sapindaceæ come in spring and early June.

In the Perigynæ the preëminently normal and typical order is Rosaceæ, standing here as the Ranunculaceæ among Hypogynæ. Somewhat later than the latter order in starting, the Rosaceæ reach perfection in late May and through June. At much the same time, but scattered along later into the summer, comes the less normal order Saxifragaceæ, of which the aberrant genus Parnassia, an odd little type, holds an isolated place in the late autumn flora. The distinctive order Leguminosæ, by far the most numerous of our Choripetalæ,

flourishes throughout the summer and well into autumn. The aberrant Drosera is summer-flowering. Rhamnaceæ, and, particularly, the diclinous Lauraceæ, and the Hamamelidaceæ, belong to spring,—though Hamamelis, oddly enough, blooms in October.

As the typical Hypogynæ are characteristic of spring, so the several more important orders of Epigynæ belong peculiarly to summer and early fall:—the great order Onagraceæ, and the Lythraceæ; in late summer the strangely organized Passiflora; in hottest July our Cactaceæ, pushed up from the southwest; and in fullest sovereignty in July and August, though stretching from May to October, the widespread Umbelliferæ; the peculiar tropical Cucurbitaceæ from July to October; the more generalized Araliaceæ mainly in spring; and the shrubs and trees of the Cornaceæ also early. The anomalous Asarum and Aristolochia are scattered from May to July.

The Sympetalæ part naturally into the Hypogynæ, isocarpal and anisocarpal; and the Epigynæ. In Hypogynæ typical Isocarpæ, the more generalized group, are Ericaceæ, coming from earliest spring late into May and early June, and, at the same time, the Diapensiaceæ and Primulaceæ, the last rather later. Pyroleæ, in which there is a reversion to choripetalism, extend into July. Polemoniaceæ, somewhat transitional to the Anisocarpæ, bloom through May, June and July. In Anisocarpæ note:—the tree-order Oleaceæ, early flowering; the parasitic Orobanchaceæ, scattered from April to October; Catalpa and Bignonia in spring, and the brilliant *Tecoma radicans* in July; the Borraginaceæ, few in spring, reach perfection in summer; Convolvulaceæ and the unique Solanaceæ, from mid-summer into autumn; the aquatic Utriculariaceæ, entirely in summer; the great specialized orders Scrophulariaceæ and Labiatæ, throughout the seasons but in greatest predominance from mid-summer late into autumn; also then the Verbenaceæ. Apocynaceæ and the highly *specialized-aberrant* Asclepiadaceæ come in mid-summer. Characteristic of autumn are the Gentianaceæ, whose relation to the two last named orders gives them a high rank. A few species occur much earlier than the typical genus Gentiana.

Turn to the Epigynæ :—Caprifoliaceæ and Rubiaceæ, though scattered, predominate in summer; Campanulaceæ, particularly in late summer and in autumn,—the finest type *C. americana*, coming in September. Late in summer and in September, the Lobeliaceæ are in fullest perfection,—the splendid *Lobelia cardinalis* and *L. syphilitica* being late. And lastly, we meet the vast order Compositæ, undoubtedly nearly the highest of flowering plants. So numerous a group would naturally spread throughout the seasons, but mark :—it comes in all its glory late in August and straightway through the autumn, when we have, among many, those gorgeous genera, Solidago and Aster. Here the fact confronts us, that in the autumn the higher Sympetalæ hold sweeping predominance over the higher Choripetalæ.

Few data of any consequence have been omitted from this review, and the evolutionary system followed has been defined step by step because upon it the fabric of the argument mainly depends. The deductions are these :—*From early spring to late autumn there is a progression in the general character of the flower-groups, from the lower to the higher,—successive groups succeeding each other in time, parallel groups coming synchronously.* And the later in order may be *types* of a higher character of development, *or* they may be *specializations* of a group whose *normal* forms belonged to an earlier season. In their blooming season, *the more perfect succeed the more simple ; the aberrant, the normal ; the specialized, the generalized.* But with the general observation arise certain modifying conditions. The blooming period may sometimes vary from the general rule to better bring the flowers among the most favorable conditions for cross-fertilization,—in the case of anemophilous pollination before referred to; or, even more obviously, in the case of entomophilous pollination, though here it is often doubtful whether the flower adapts itself to the insect's season or vice versa. Again, plants that are frontiersmen from the characteristic vegetation of a hotter clime may be expected in the hottest of the seasons,—e. g.: the Cactaceæ. There is an evident limitation of the flowering of our trees and shrubs to spring and earliest summer. This may largely be due to the excess of vital energy held stored up in

woody trunks and branches,—and in Coniferæ in the evergreen foliage,—ready to burst forth with the first coming of warmth. Diclinism is most frequent in the spring months,—where this occurs in the lower groups of plants the case is covered by the general principle; but when diclinism obtains in highly specialized forms, as a result of retrogressive evolution, the problem becomes difficult,—the interesting question suggests itself: Does reversion in structure here revert the flowering period to an earlier season? As a case in point, recall the genus Carex. Again, there is a determining function in the character of the flower's habitat:—The spring flowers seek largely the protection of the woodlands; marsh-plants reach perfection mainly in latest spring and through the summer, though some, like Caltha, are early; the aquatics of ponds and river glory in the summer sun; and the flowers of meadow and prairie and thicket-margin luxuriate from mid-summer to the end of autumn. This last recalls the recent observations of Conway McMillan on "tension-line flora," and we note with interest that the highly organized tension-line flora gives us our later blossoms to a large extent. Further, every practical botanist knows that the herbaceous flora of summer, as a whole, shows a great advance in *vegetative* luxuriance over the corresponding flora of spring. But it does not follow that that of fall in turn advances, for vegetative luxuriance means primarily—heat. Yet the truth remains that this is not the fundamental criterion of plant aristocracy,—in the giant calamite of geologic ages flowed humbler blood than flows to-day in the dandelion of our backyard grass-plots. So each new factor that arises, far from weakening, but adds significance to the fundamental principle.

Here the question rises: Why should there be a correspondence between the course of the flower seasons and the system of floral evolution? Solve this, and the "philosophy of flower seasons" is an open riddle. But for the present it is only possible to indicate the direction in which the answer probably lies: The most simple and generalized forms, coming first in the course of floral evolution, have had the longest time in which to adapt themselves to existent climatic conditions;

and, reciprocally, climatic conditions have become more and more favorable to the rapid development of the said forms. So a floral type that ages ago would have reached its perfection only after a long continuance of favoring season, now may burst into the fulness of its maturity with the first warmth of spring. But as change succeeded change in the course of time, a maximum point would be reached, from which the conditions would become less and less favorable to the rapid development of types surviving from an earlier age. Then these would dwindle from the earth,—replaced, driven out, by those that had come into existence in a later age. Thus, in the ages to come, the early flowers of to-day will disappear; to be replaced by what are now our later flowers; whose place, in turn, will be filled by forms that are yet to be. All this is but a bare suggestion, yet in it may be, perchance, the spark of truth that will guide further observation to a more definite decision.

This very relation between flowers and seasons that the evolutionary floral system brings to light, may, in turn, modify somewhat that system, and so eradicate many seeming anomalies. And thus the added law may be better established by the perfecting of the fundamental one,—and vice versa. This consideration cannot be ignored.

In the light of all these facts and their regulating principles we can feel with fullest power that harmony of relations in the flora of each succeeding month,—a harmony to which even the casual observer cannot be insensible. The quarter of our country we have scanned is a wide sweep—coast-plain, hill-regions, mountains, and prairie; and if it offers so significant suggestions we can justly say, inductively, that there must be much here that is of far wider application. At least, there is full cause to believe that more extended research in this little-tested field of flower philosophy will be well repaid; and it may, further, open up an analogous field, yet unthought-of, in the realms of lower, flowerless, plant-life. The story told, we realize that its plot is simply another instance of the expression of universal law in that which rather seems a law unto itself.

# THE MORPHOLOGY OF ROOT TUBERCLES OF LEGUMINOSÆ.

ALBERT SCHNEIDER, M. D.[1]

The object of this research was to give a more detailed account of the anatomical structure of root tubercles, thus adding perhaps somewhat toward clearing up some of the difficulties in the comparatively little known field of teratology. It is true much labor has been expended in the endeavor to get a correct understanding of "symbiosis" and the relation of *Rhizobia* to certain plants. The life history and morphology of the root bacteria have received most of the attention while the tubercles themselves have been almost entirely forgotten. Frank, who has done much in this line of research offers but little concerning tubercle morphology. Nearly all of his attention is directed toward the "*Bakteroiden.*" The same is true of Beyerinck, Brunchorst, Waronin and the others. Some of the pupils of Frank have also made noteworthy researches concerning Rhizobia. Recently Frank and Moeller[2] have engaged in a controversy with regard to the "*Dimorphismus der Wurzelknöllchen der Erbse.*" Frank has also described the lenticular structure of root tubercles. Beyond this, little of importance seems to have been done with root tubercle morphology.

In my own researches, mature tubercles were taken from various *Leguminosæ* toward the close of the vegetative period, since at that time tissues have acquired their most marked morphological characteristics. The earlier stages of development were studied at various periods of the season. The final summing up was not completed until late in the year. (Dec., 1892.)

The tubercles are in themselves abnormal growths produced by the local irritation of certain organisms, the Rhizobia; and

[1] The investigations described in this paper were carried on in the laboratories of botany, of the University of Minnesota.

[2] Berichte der deutsch. bot. Ges., Hefte 3 und 5, 1892.

etiologically resemble those growths produced by certain animals as for example the *Heterodora* or *Anguillula* cysts found on some roots. Morphologically, however, they are clearly distinct.

In some cases these tubercles make their appearance shortly after germination. In others not until plants have reached the flowering stage or even later. In some cases they do not appear at all, that depending upon the nature of soil in which the plants grow as explained by Frank[3] and others. The macroscopic appearances of some tubercles have been more or less perfectly described in a previous article.[4] The form is quite constant in a given species of plant. In *Phaseolus vulgaris* and *Amphicarpaea comosa*, for instance, they are spherical. In *Melilotus alba*, *Pisum sativum*, *Trifolium pratense* and *Trifolium repens* they are oblong, narrow at point of attachment, often slightly forked, cordate or pear shaped. Usually they occur singly, less often, as for example in *Melilotus alba* they grow into large grape-like bunches. Like root branches they usually develop acropetally though there are numerous exceptions. They are most common on roots near the surface of the soil; sometimes they are found at a considerable depth. They are never found in close proximity to growing root tips. They occur either on the main root or its branches.

Tubercles seem always to develop exogenously. The direct causes of their development are the Rhizobia, of which there are at least several species.[5] Predisposing causes are, nature of soil and condition of atmosphere as to temperature and moisture, etc. The various kinds of Rhizobia appear to be more or less abundant in all normal soil. Whenever a given species finds a suitable lodging place on the root-surface it multiplies and by some means gains access to one or more of the surface cells and infection is completed. Just how infection takes place is not definitely known. It is thought that the Rhizobia have the power to dissolve the cell membrane of the host; just how is not stated. Frank, Moeller[6] and others maintain

[3] Pilz symbiosa der Leguminosen, 1890.

[4] Bulletin Torrey Bot. Club, July, 1892.

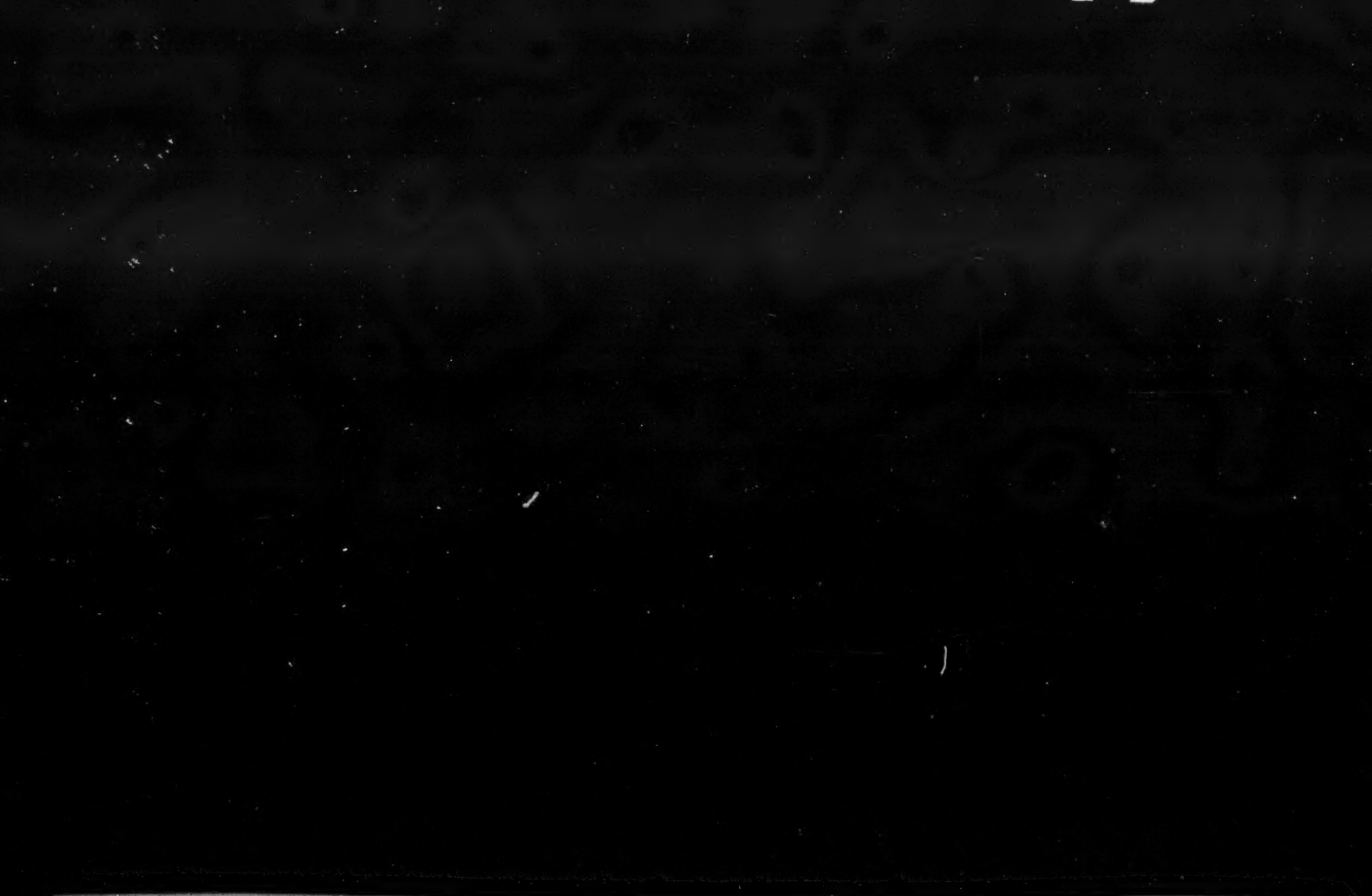
[5] Bulletin Torrey Bot. Club, July, 1892.

[6] Ber. der deutsch. bot. Ges., Heft 5, 1892.

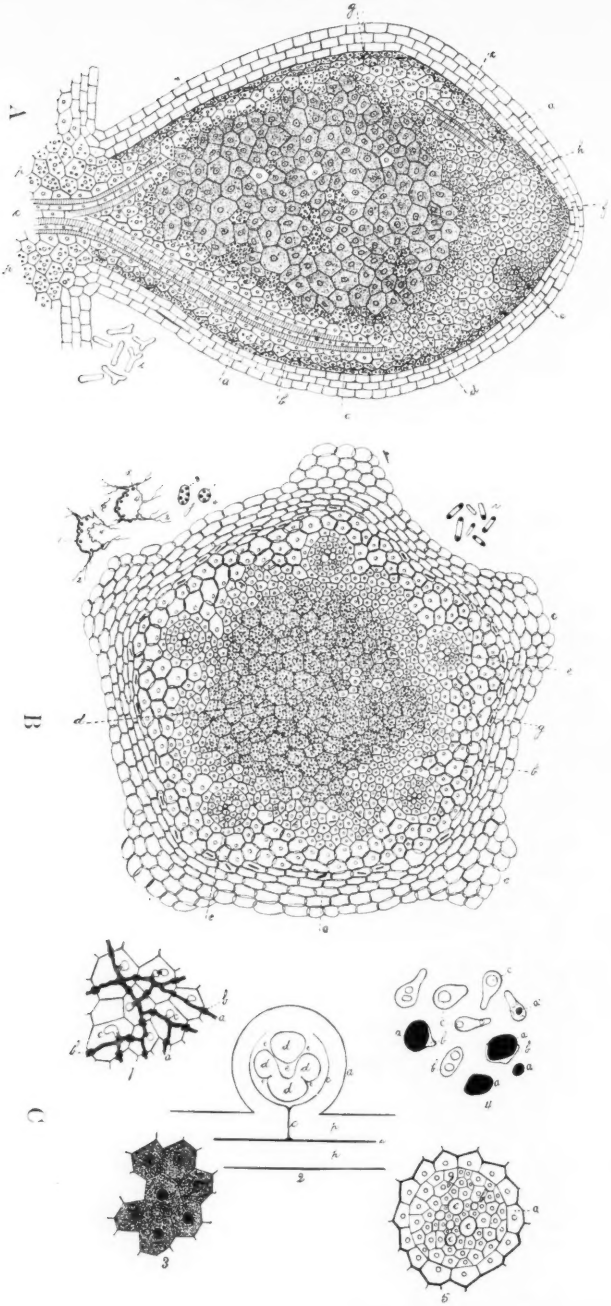
that infection takes place by means of the "*Infektionsfäden.*" This seems improbable since the "*Infektionsfäden*" are not always present. I could find no trace of them in *Phaseolus vulgaris.* They are sometimes present in *Trifolium pratense.* I have been unable to find them in *Robinia pseudacacia,* although Moeller states that they are present. In all those cases in which I found them I could detect no connection between them and the Rhizobia. They are sometimes found in tissues outside of the tubercle having no apparent connection with it. In chemical behavior and microscopical appearance the "*Infektionsfäden*" differ considerably from the Rhizobia. The "*Infektionsfäden*" consist of a more highly refractive albuminoid substance and stain less readily than the Rhizobia. I have often found them in old tubercles of *Trifolium pratense* in which the Rhizobia and cell protoplasm had been almost wholly removed showing that they have a greater vitality than either the plant cell or the Rhizobia. Heretofore no one has been able to detect a membrane on the "*Infektionsfäden.*" Recently Moeller[7] has announced the discovery of a cellulose membrane surrounding the "Bacteria zoogleæ"—"*Infektionsfäden.*" This membrane, he asserts, is secreted by the cell protoplasm as a protection against the intruding bacteria (Rhizobia). In the same article Moeller notes that the bacteria (Rhizobia) have the power to dissolve cellulose. These statements are certainly a little difficult to understand. It would seem improbable that the bacteria (Rhizobia) should at one and the same time dissolve cellulose and also have a coating of it deposited on them as a protection against their intrusion. It is known that eggs of parasites, larvæ in the resting stage, calcium oxalate crystals, etc., when found in plant tissues have had secreted around them a coating of cellulose. In such cases, however, the foreign substance does not at the same time have the power of dissolving cellulose.

Without going into further discussion, it is known that the Rhizobia gain access to the interior of the surface root-cells where they multiply rapidly. By their irritating presence, increased protoplasmic action takes place. Not only do the

[7] Ber. der deutsch. bot. Ges., Heft 5, 1892.



# PLATE XVII.



Root Tubercles of Leguminosæ.

infected cells grow and multiply much more rapidly but the adjoining cells likewise take on increased activity. On microscopic examination there will be noted a slight protuberance, swelling outward but still covered by the root epidermal layer. This incipient tumor consists of two kinds of meristematic tissue, the centrally located portion of infected cells and the adjoining outer portion of noninfected cells. This meristem tissue is engaged in active cell division. The original infected cells divide and produce auto-infected daughter cells. Outwardly a corky tissue is developed from a distinct phellogen layer, usually one or two cells in thickness. These phellogen cells divide tangentially and often contain starch and calcium oxalate crystals. I have found a cork layer on all tubercles examined thus far. Centrally cell division goes on less rapidly until the pericambium of the root is reached which is also involved in the change. A vascular bundle starts from the root-vascular system and extends peripherally toward the infected area until quite near it where it divides into from four to seven branches which continue centrifugally (in reference to root) through the outer part of the tubercle meristen to near its apex. These vascular bundles consists of conducting vessels, like those of the root, surrounded by bast cells: the whole is encircled by a sheath of cells whose outer walls are considerably thickened.

In spherical tubercles the cambium is of equal thickness in all parts. In elongated and irregular forms the meristematic tissue is more abundant in the extended points, that is, there may be one or more apical areas in the same tubercle. The cambium cells are of the ordinary small, angular, closely united, rather thin walled variety. The cells may divide in any plane. The cork layer usually consists of thin walled rectangular cells, often with intercellular air passages. In *Phaseolus vulgaris* the cork cells are considerably rounded, in Robinia they are rather irregular. The entire cork layer is continuous with the unchanged endodermal layer of the root. The entire tubercle is covered over by an epidermal layer of cells contiguous with that of the root. No root-hairs are present. Early in the development of the tubercle the root-hairs become

dwarfed and soon disappear. The plant can no longer use them as organs of absorption on account of the impervious layer of cork. The tubercle receives its nourishment by means of the vascular bundle system and the parenchymatous conducting tissue of the root which is continuous with that of the tubercle. The outline of the infected area is wavy, there being a depression before each vascular bundle as seen in a cross section. Single, or groups of noninfected cells are generally distributed through the infected area. In the centre may be found a noninfected area of considerable size, as in *Robinia pseudacacia.* The infected cells resemble those of the noninfected cambium in that they are angular and closely united, there being no intercellular spaces. They differ in that they are much larger and in that they have undergone peculiar protoplasmic and nuclear changes. The cells are entirely filled with Rhizobia and protoplasm. The Rhizobia feed upon the cell protoplasm and in turn appropriate for the use of the plant the free nitrogen of the air. In the case of *Rhizobium mutabile* the abundant food supply causes it to become much enlarged and to assume various forms during the season, hence the name. No other species seem to undergo such extensive changes. As to the position the Rhizobia take in the cell, I have noticed some peculiarities. In colonies of *Rhizobium mutabile* in *Melilotus alba* the long axes are all directed toward the nucleus. *Trifolium* which contains the same species of Rhizobium does not show the same arrangement. Here they are placed in all concievable positions. Why they should take this position in *Melilotus alba* I am unable to state. In *Phaseolus vulgaris* and *Pisum sativum* they are often collected into Zoogloeae as is clearly shown in thin sections.

In *Amphicarpaea comosa* and *Phaseolus vulgaris* I have always found well developed lenticels on the tubercles. They are developed from a clearly marked lenticular phellogen, showing tangential cell division. The phellogen of the lenticels as well as that of the cork layer is developed from a large celled parenchymatous tissue lying above the cambium layer. The lenticular phellogen is not depressed into the underlying tissue, as is usually the case, but somewhat elevated above it. The

lenticels consist of the usual loosely connected, rounded cork cells and are always located above the vascular bundles. They no doubt serve as a means for the interchanging of gases between the exterior and interior by way of the vascular bundles. Frank maintains that the cork layer as well as the infected area have intercellular air spaces for the interchange of gases. As already mentioned the infected area consists of closely united firm walled cells, such as are usually found in meristematic tissues. Furthermore the infected area is entirely cut off from the cork layer by means of the cambium which certainly has no intercellular passages. Hence it would be rather difficult to see what function intercellular spaces would play in the infected area. Tubercles possessing lenticels no doubt give off considerable gas. I have noticed that the tubercles of a growing bean plant when placed in water would have a glistening appearance due to a thin layer of air or some gas separating them from the water. After a time very minute gas bubbles would form on the surface of the tubercle. As to the source and nature of this gas I am unable to give any satisfactory explanation. It is very likely dependent upon the largely increased metabolic processes going on in the tubercle, Frank has made some experiments on the subject without however, coming to any definite conclusions.

Starch is usually present to some extent in tubercles, especially in those infected by *Rhizobium mutabile.* There is some in tubercles of *Amphicarpaea comosa,* little or none in tubercles of *Phaseolus vulgaris* and *Robinia pseudacacia.* The starch is always found in the noninfected meristem tissue especially the cork phellogen and next to the infected area. This is simply *stored starch* like that found in other parts of the root.

Frank maintains that there are two varieties of Rhizobia always to be found in two different kinds of tubercles of *Pisum sativum.* One variety is said to have the power of producing within itself highly refractive amyloid bodies closely related to amylo-dextrin found in some of the Florideae. Moeller agrees with Frank in regard to the presence in some Rhizobia of the highly refractive bodies but maintains that they consist of some fatty derivative, as cholesterin. Both agree that these

bodies are readily stained with iodine solution, but while Frank notes a reddish brown stain Moeller affirms the color to be dark brown. I have noted similar highly refractive bodies in *Rhizobium mutabile* of *Melilotus alba, Trifolium pratense, Trifolium repens,* and *Lathyrus odoratus* but not in *Phaseolus vulgaris,* or *Pisum sativum.* These two last named plants are infected by *Rhizobium Frankii* var. *major* and *minor* respectively. So far I have only found these bodies in *Rhizobium mutabile.* These bodies are, as before stated, highly refractive; generally rounded, and may be located in the centre or toward the periphery of the usually more or less modified *Rhizobium.* I have been unable to stain them with tincture of iodine. Fuschin stains them with difficulty. The various aniline dyes have practically no effect upon them. As to their chemical nature I am not prepared to express a definite opinion. I am of the opinion that they are not starch. I am more inclined to Moeller's view that they are due to a fatty degeneration of protoplasm in improperly nourished Rhizobia. This would especially be expected in mature degenerating tubercles, which are the only ones that contain the Rhizobia with refractive bodies. Fatty degeneration is quite common in animal protoplasm. It sometimes happens that a starch granule is deposited inside of the partially or wholly empty case of a Rhizobium. This however is purely accidental and does not occur often. Of course such Rhizobia will contain highly refractive bodies that stain readily with iodine.

The greatest changes take place in the infected area of the tubercle. Here everything points to increased protoplasmic activity. The cells grow and multiply rapidly, they are entirely filled with a mixture of Rhizobia and protoplasm and in some cases the "*Infektionsfäden.*" The nuclei are abnormally large, the nucleoli become more distinct. All the different cell elements stain much more heavily than those of the normal cell. In *Phaseolus vulgaris* the nuclei becomes very much modified, they increase in size, the nuclear wall thickens, sooner or later the weaker spots of the wall give way and allow the nucleoplasm to protrude giving the whole an amoeba like appearance. Finally the nuclear wall ruptures on one side

and allows the nucleoplasm to escape and mix more or less with the cell protoplasm (cytoplasm). The nucleoli retain their normal size and form; some of them retain a position next to the nuclear wall, others escape into the "mycoplasm" of Frank. I have not noticed such extensive nuclear changes in any tubercles except those of *Phaseolus vulgaris*.

The question as to what becomes of the contents of the infected cells might be briefly considered. Formerly I expressed it as an opinion that the plant at the close of the vegetative period and also at other suitable times absorbed the protoplasmic contents of the Rhizobia. I do not now think that that is the rule if it occurs at all. I believe that normally the tubercles are destroyed by the ordinary process of decay and the Rhizobia thus liberated. I have found the usual number of tubercles on *Trifolium pratense* and *Melilotus alba* as late as December 10th when I was compelled to chop them out of the frozen ground. The tubercles were filled with *Rhizobium mutabile*, apparently in normal condition. I have found well filled tubercles on dead, matured plants of *Phaseolus vulgaris*. The Rhizobia were apparently in a resting stage, waiting to be liberated. It is true in some cases the tubercles were emptied during or before the close of the vegetative period. Even in such cases I do not believe that the contents were taken up by the host but rather that the tubercles died and decayed because it did not receive enough nourishment from the plant and soil.

The question as to what position the tubercles hold, morphologically considered, is of some interest. The absence of a root-cap, of root-hairs and the fact that it develops exogenously would show that it does not resemble a root-branch. In position it shows neither positive nor negative geotropism though it occurs most frequently on roots near the surface. That may be, as Frank maintains, because the tubercles require a coating of air to keep them from direct contact with moisture. But since the tubercle is nourished by the plant and the coating of air escapes from the tubercle itself it is difficult to see why they should not develop in deep soil as well. It may be that there is a tendency toward negative geotropism. I have never been able to find tubercles on any other part of the plant than

the root or its branches. Frank has found Rhizobia in stem, leaves and even the embryo. I have searched for them repeatedly in tissues outside of the root but have not found any. Tubercles resemble growing tissues in the abundance of Albuminoid compounds. Calcium oxalate crystals are common in the noninfected cambium especially the cork phellogan. Some of the crystals have a coating of cellulose secreted around them by the cell protoplasm. Any abnormal growth resembles histologically the tissue upon which it develops; hence one would expect the tubercles to resemble anatomically the roots upon which they grow. Yet it seems that the tubercles have more anatomical characters belonging to a stem than to a root, as already indicated.

## Resume.

1. Root tubercles develop exogenously.
2. Tubercles grow from a meristematic area surrounding the infected region and separating it from the external cork layer.
3. Cork as well as lenticles develop from a well marked phellogen.
4. Tubercles have a well developed vascular system differing from that of the root.
5. *Phaseolus vulgaris* and *Amphicarpaea comosa* have tubercles with well developed lenticels, differing somewhat from those on the stem.
6. There is more or less starch in tubercles produced by *Rhizobium mutabile.*
7. Sometimes *Rhizobium mutabile* contains highly refractive bodies whose nature is not definitely known.
8. Anatomically a tubercle resembles a stem more closely than a root.
9. Generally tubercles are not found empty at the close of vegetative period.
10. Probably the plant does not reabsorb the protoplasmic contents of the Rhizobia at any time.
11. Nuclei in tubercles of *Phaseolus vulgaris* undergo great changes.

## Explanation of Plates.

A. Longitudinal section of a mature tubercle of *Melilotus alba.*

a. Cork layer.
b. Phellogen.
c. Vascular bundle in longitudinal section.
d. Infected area showing the Rhizobia radiating from the nucleus as a centre.
e. Vascular bundle, cross section.
f. Apex of cambium layer.
h. Starch layer next to infected area.
i. *Rhizobium mutabile* of *Melilotus alba* as seen in the early part of November.
j. Calcium oxalate crystals.
k. Parenchymatous tissue continuous with that of the root.
r. Noninfected cells in the infected area bearing starch.

B. Cross section of a tubercle of *Phaseolus vulgaris.*

a. Cork layer consisting of rounded cells.
b. Phellogen.
c. Lenticels.
d. Infected area, Rhizobia are arranged in zoogloeae.
e. Vascular bundles, all in cross section.
g. Calcium oxalate crystals.
i. *Rhizobium frankii* var. *majus* from bean tubercle.
j. Normal nucleoli. 1. Nuclear wall. 3. Nucleoli. 4. Nucleoplasm.
k. Much modified nuclei form infected area. 1. Nuclear membrane. 2. Processes of the nucleoplasm. 3. Nucleoli. 4. Nucleoplasm.

C. Details.

1. Small portion of tubercle of *Trifolium pratense* invaded by the "Infektions fäden" (*Schinzia leguminosorum*). a. Hyphæ of the fungus. b. Enlargements next to cell wall. c. "Haustoria."

2. Diagrammatic longitudinal section of *Robinia pseudacacia*. a. Cork layer. The cells are more irregular than those of the root. c. Vascular system. d. Infected area. e. noninfected areas.

3. Same as 1, but without the "Infektions fäden" and showing the cell entirely filled with the much modified *Rhizobium mutabile*. Nuclei are much enlarged and nucleoli show distinctly.

4. b. Much modified *Rhizobia mutabilia* with highly refractive bodies c. a. Starch granule which is capped by the empty case of a Rhizobium, b. á. A starch granule just forming inside of a partially empty Rhizobium case. a. Some free starch granules.

5. Cross section of a vascular bundle. a. Sheath. b. Phloem. c. Vessels.

# ON THE STRUCTURE OF THE CARAPACE IN THE DEVONIAN CRUSTACEAN RHINOCARIS; AND THE RELATION OF THE GENUS TO MESOTHYRA AND THE PHYLLOCARIDA.

By John M. Clarke.

In the original account of the peculiar fossil *Rhinocaris*,[1] the carapace was described, from the best evidence then obtainable, as univalvular, with a rostrum projecting conspicuously and consolidated with the valve. The type of structure appeared to be a remarkable departure from that exemplified in the prevailing phyllocarid crustacea of the Devonian (*Echinocaris, Elymocaris, Tropidocaris*), and seemed to evince in the very structure mentioned, strong affinities with the Decapods.

The diagnosis of the genus was virtually based upon a single specimen in which the carapace had been laterally compressed in such a manner as to demonstrate the non-existence of a median suture or hinge, and to conceal any evidence of other longitudinal sutures; and in which, also, the rostrum was laterally flattened and apparently continuous with the carapace.

For several years I have been carefully searching for additional information concerning this peculiar crustacean. A considerable number of specimens from the shales of the Hamilton group of Ontario County, New York, have come into my hands, but the test of the animal is so very tenuous that it seems well nigh impossible to secure examples which have not been subjected to some distortion, and that is usually the greatest at structural points of critical importance. Several excellent specimens, however, have been obtained, some of them kindly furnished by Mr. F. B. Loomis, of Spencerport, N. Y.

The carapace of *Rhinocaris columbina* Clarke, (the typical

[1] Palæontology of New York, vol. vii, pp. lviii, 195, pl. xxxi, figs. 16–21, 1888.

species) consists of four distinct and separate parts; two broad lateral plates or valves, a narrow median or axial plate, and an anterior median plate or rostrum.

*The valves* have an elongate, somewhat semi-oval marginal outline, narrower posteriorly than anteriorly, with a truncate or concave posterior extremity. They come into contact at only a single point, and that is in the axial line at about one-fourth of the median length from the anterior margin. At this point a projecting angle is formed on each by the attenuation and termination of the rostrum and median plate, and the projecting points appear to come into simple apposition, though it is possible that they slightly overlap; there is, however, no satisfactory evidence of the clasping of the valves at this point, such as that occurring in the great species *Mesothyra Oceani.*[2]

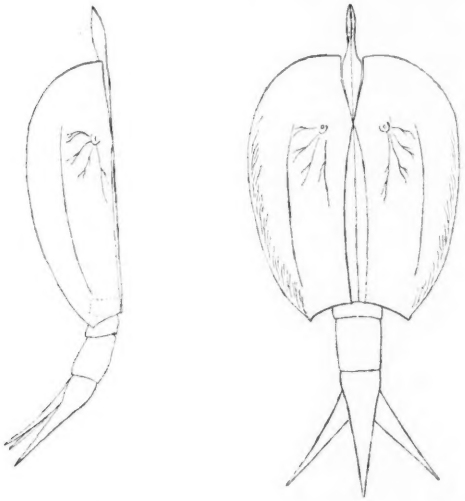


FIG. 1. Diagrammatic figures showing the carapace structure in *Rhinocaris.*

Opposite this point of contact and considerably within the median line of each valve, is a visual node having the form

[2] *Op. cit.* pl. xxxii, fig. 6; pl. xxxiii, figs. 4, 5.

of a low pustule with a single central depression or pit. From the base of this node radiates a series of linear, sparsely branching sinuses which extend laterally and posteriorly toward the marginal regions, the longest traversing nearly one-third the length of the valves. There is a very faint ridge or carina which lies just outside the middle of each valve and extends subparallel to the outer margin, for nearly the length of the valve, though reaching neither its anterior nor posterior margin.

In addition to these characters, the valves, over the marginal regions, bear the fine anastomosing elevated lines which characterize all the phyllocarid crustacea.

*The rostrum* is an elongate plate having, when flattened horizontally, somewhat the form of a willow leaf. Its broader end is inserted into the anterior gap between the valves and its posterior extremity is acute. As the plate begins to project beyond the anterior edge of the valves of the carapace, it narrows, its lateral expansions become deflected, the median portion tapering rapidly and becoming slightly incurved toward the tip.

The plane of the anterior half of the plate stands at nearly right angles to that of the posterior half, as shown in the accompanying figures. That this organ is in symphysis with

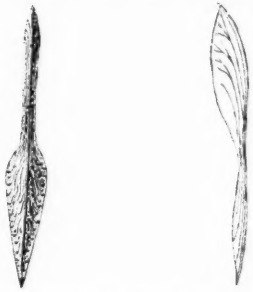


FIG. 2. Dorsal view and outline profile of the rostrum of *Rhinocaris columbina*.

the valves is evident from the fact that it is rarely found in its normal position. The surface is peculiarly ornamented by a series of elevated lines forming a sort of midrib; over the lateral posterior expansions the lines become much finer, diverge

radially from the center after the manner of leaf veins, anastomosing to some degree, frequently terminating in oblique punctæ, and in parts where the lines disappear the punctæ remain.

*The median plate.* This is a very narrow body, its width exceeding at no point the greatest diameter of the rostrum. It begins at the union of the valves, in an acute angle, but its lateral margins soon become subparallel or convex outwardly. In relative proportions its length is about eight times its width.

Along the median axis it bears an elevated ridge-like line, from which there is a gentle slope on each side, and it was essentially from this evidence of continuity of the test on the axial line and from the concealment of the sutures between this plate and the valves, that the carapace was originally described as univalvular. The fine incised lines of the surface diverge anteriorly from this ridge.

In discussing, in Volume VII of the Paleontology of New York,[3] the structure of the great carapaces from the lower

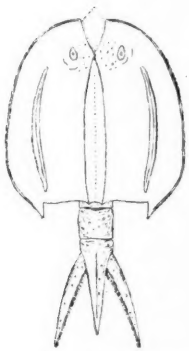


FIG. 3. *Mesothyra oceani.*

Chemung beds at Ithaca, N. Y., which had theretofore been known as *Dithyrocaris neptuni*, it was shown that these carapaces (now termed *Mesothyra oceani*) must have had a composition similar to that we now find to have actually existed in

[3] *Op. cit.* p. 184, pl. xxxi, figs. 8–10.

*Rhinocaris.* This presumptive structure was exhibited in a diagrammatic figure upon Plate xxxii, of which a reduced copy is here given. Though neither the rostrum nor the median plate in *Mesothyra* has yet been seen, all doubt of their existence is removed, and it affords a personal gratification to find this reconstruction of *Mesothyra* so fully substantiated by our present knowledge of the carapace in *Rhinocaris.*

FIG. 4. The median plate of *Rhinocaris columbina.*

The structure of the visual organ affords a further correspondence in the two genera, and one of some morphological significance.

In regard to the number of abdominal segments, present evidence indicates a difference in the two, *Rhinocaris columbina* having at least three, and *Mesothyra* having shown but two.

In the genus *Tropidocaris* Beecher, it has been shown that the type species, *T. bicarinata,* possesses a rostrum,[4] and its anterior extension is not unlike that of *Rhinocaris,* but there is now no satisfactory evidence of a free median plate in any of these species. Unfortunately the accessible specimens of the species are not very satisfactorily preserved, and the originals described by Mr. Beecher in Report PP of the Second Geological Survey of Pennsylvania, are understood to be beyond the reach of further investigation for the present. In plaster casts of the originals, the median suture on the hinge appears to be invariably in the longitudinal axis of the test. The original specimens of *Rhinocaris scaphoptera* and *Tropidocaris hamiltoniæ,* which were collected by me in the Hamilton shales of Ontario County, N. Y., both show some evidence of a quite narrow median plate, and the former possesses a stout rostrum,[4] while in the *Mesothyra* (*Dithyrocaris?*) *veneris,* from the Marcellus shales, both median plate and rostrum are distinctly seen.[5]

It may be questioned if the multicarinate carapaces composing the genus *Tropidocaris* should be placed in close asso-

[4] *Op. cit.* pl. xxxi, fig. 22, 23.

[5] *Op. cit.* pl. xxxiii, fig. 3.

ciation with the unicarinate carapaces such as are possessed by *Rhinocaris columbina, R. scaphoptera, Mesothyra oceani, M. (Dithyrocaris?) veneris, Tropidocaris hamiltoniæ,* etc. All the latter appear to have possessed the carapace structure of *Rhinocaris columbina,* and if they are to be considered as representing different modifications of this type, sufficient to entitle them to distinct generic appellations, the following division of them may be preferable to that now standing: under *Rhinocaris; R. columbina, Mesothyra veneris;* under *Mesothyra; M. oceani, Tropidocaris hamiltoniæ, Rhinocaris scaphoptera.*

In regard to the unicarinate genus *Argas,* or *Dithyrocaris,* it may be stated that as described and illustrated by European writers, it has not been shown to exist in the paleozoic faunas of North America. When the structure of the carapace in the type species shall become more precisely known, we shall have a better basis for the comparison of these fossils with those under consideration, but at present we are not justified in assuming that they possessed the same structure as the unicarinate Rhinocarids.

Leaving these points of systematics, we find in *Rhinocaris* and its allies a remarkable carapace structure, an explanation of which it is difficult to find among fossil or recent crustaceans. We may conceive the double suture to have been a temporary modification of the Ceratiocarid type, induced by a necessity for movement of the lateral parts of the carapace after anchylosis has become established along the original median hinge. The evidence favors the belief that the valves were capable of motion along the double hinge, and nearly every specimen demonstrates the fact that the parts were separable along these lines after but slight maceration of the tissues.

No satisfactory elucidation of the origin and morphological significance of this structure appears from a study of the embryological phases of *Nebalia* as given by Metschnikoff, Claus and Packard, nor in the development of the Decapods as shown by Sars, S. I. Smith, Brooks, Bumpus and others. It is, nevertheless, in the development history of *Nebalia* and the

Decapods that the key to the taxonomic value of these features must be sought.

The existence of such a structure among the fossils usually classed as Phyllocarida, suggests a question as to the latitude of this ordinal term, proposed by Packard in 1879, for the living *Nebalia* and its fossil allies. The hinging, or median division by suture, of the carapace in many of these creatures, has been regarded here as among the Phyllopods, as of minor importance by most authors who have agreed to associate with *Nebalia* such fossil forms as *Ceratiocaris*, *Echinocaris*, etc. Claus used the term *Leptostraca* (also founded upon the structure of *Nebalia*) with a somewhat more restricted meaning. In a recent work on the *Ceratiocaridæ* of Great Britain, the authors, Professor T. Rupert Jones and Dr. Henry Woodward, have divided the Phyllocarida into two groups (1) those with univalved, and (2) those with bivalved carapaces. The greater number of the genera included in the first of these divisions are imperfectly known and quite obscure in their structural relations. Such are *Discinocaris*, *Spathiocaris*, *Aptychopsis*, *Ellipsocaris*, *Dipterocaris*, etc., etc. As the living *Nebalia* is univalved and without hinge, it is in this division that one would expect to find the closest approach to its structure, and it is, in fact, the case that none of the so-called Phyllocarida approaches *Nebalia* so closely in the structure of the test as the early paleozoic (Cambrian) genus *Hymenocaris*. In both, the telson is represented by a modification of three pairs of caudal spines or setæ, and both have about the same degree of abdominal segmentation, though *Nebalia* possess a rostrum, while *Hymenocaris*, as far as we now know, is devoid of one.

FIG. 5. *Hymenocaris vermicauda.*

FIG. 6. The flattened carapace of *Nebalia bipes*. (After Packard.)

Another very early univalved species, not unlike *Nebalia*, but wonderfully similar to the living Phyllopod *Apus*, is the *Protocaris marshii* Walcott, from the Olenellus-zone of the Cambrian. The figures here introduced, taken from the works of Walcott and Packard, will serve to show this similarity. The

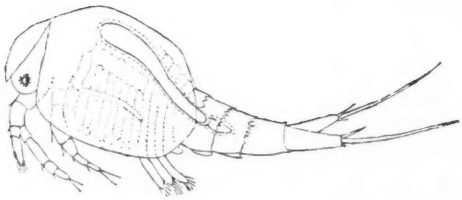


FIG. 7. Young of *Nebalia geoffroyi*. (After Metschnikoff.)

single example of *Protocaris* known, has probably been subjected to some horizontal distortion in the shale, giving the carapace a disproportionate size with reference to *Apus*, possibly also serving to obliterate any external evidence of ocular nodes which may have existed, but the remarkable closeness in the form of the abdominal segments, the degree of segmentation and the single strong pair of caudal processes, renders it highly probable that in *Protocaris*, we have to do with an apudiform phyllopod rather than with a nebalioid phyllocarid.

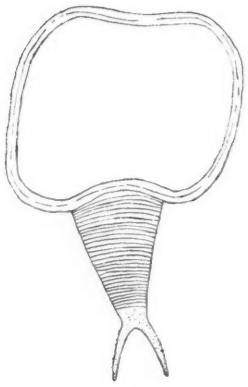


FIG. 8. *Protocaris marshii*. (After Walcott.)

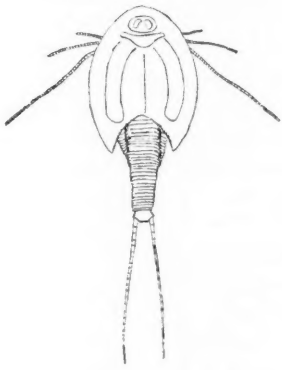


FIG. 9. *Apus æqualis*. (After Packard.)

Among the bivalved genera, not including *Estheria* and *Leaia* which Messrs. Jones and Woodward have placed with the Phyllocarids, there is throughout a general resemblance to

*Nebalia* except in this division of the carapace; a rostrum was present in most, though in some, as *Echinocaris*, a large amount of material has as yet failed to establish its existence. *Nebalia* possesses stalked compound eyes, which make no node or other configuration upon the exterior of the carapace. In *Echinocaris*, one of the numerous nodes in the cephalic region is undoubtedly ocular, and sometimes shows a slight depression at its summit; the other nodes are probably of muscular origin.

In *Ceratiocaris* there is no external evidence of eyes, while *Emmelezoe*, *Tropidocaris* and *Elymocaris* all possess nodes which may be definitely referred to the ocular organ.

Figures of *Emmelezoe* given by Jones and Woodward indicate that its structure is similiar to that of *Rhinocaris*, and it is evident that differences of structure in this respect between all of these genera and *Mesothyra* as represented in the accompanying figures, is simply one of degree. It is, therefore, a pertinent query whether such a fixed external ocular body as this, with a single central depression, is in any way indicative of stalked compound eye. We are strongly of the opinion that it is not, but, rather, indicates that these ancient representatives of nebaliad structures were sessile eyed.

Among the crustaceans we have been considering there appear to be at least four types of test-structure which are well distinguished.

1. That of *Apus* (*Protocaris;* a synthetic type, not necessarily a Phyllopod because *Apus* is one.
2. That of *Nebalia*, in a restricted sense (*Hymenocaris*).
3. That of *Ceratiocaris* (*Echinocaris*, *Elymocaris*, etc.).
4. That of *Rhinocaris* (*Mesothyra*, *Dithyrocaris* ? ?).

It was proposed, when *Rhinocaris* was believed to represent a univalved, rostrate carapace, to distinguish it not only as a genus, but as a separate family, *Rhinocaridæ*, from other Phyllocarids; and it was at the same time proposed to place *Mesothyra*, with a supposed structure which we have now shown to exist in *Rhinocaris*, in a distinct family, the *Pinnicaridæ*. It is now evident that the two fossils are very closely related and it will not do to separate them by more than a generic difference; we may therefore retain the family term *Rhinocaridæ* and discard the other.

# GENERAL PHYSIOLOGY AND ITS RELATION TO MORPHOLOGY.[1]

By C. O. Whitman.

It is only as a zoologist that I venture to discuss this subject; and only in this capacity that I undertake to defend the proposition, that *general zoological physiology* is the promising field in which morphology and physiology may work most profitably together.

Morphology and physiology are two quite distinct sides of biology, each with definite and constant peculiarities of method and aim; but these two sides are only the statical and the dynamical aspect of one and the same thing; one presents the *feature*, the other the *expression*. It is only as a matter of convenience that these two aspects are dealt with separately; they are complemental, and have their full meaning only when united. The same function may appear in different forms, but a knowledge of the forms is nevertheless indispensable to an understanding of the function, and, conversely, the function must be known before we can arrive at a complete interpretation of the form. The best interests of biology demand that morphology and physiology should be kept in working contact. That is the lesson of the hour, which thoughtful investigators on both sides are coming more and more to realize. The separation of these two great branches of biology has been carried to an extreme that impedes the progress of both—an extreme that is unnatural and that has resulted from keeping physiology too exclusively in the service of medicine.

Physiology has come to mean, in practice at least, little more than the science which treats of the functions of fully developed organs. That this is an important side of physiology goes without saying, but there is another side no less important, which has been hitherto left almost wholly to mor-

[1]From the Fifth Annual Report on the Marine Biological Laboratory of Wood's Holl, 1892.

phologists. That we have to deal with functions of organisms as well as with functions of organs, is a truth that could not escape the student of Darwin's or Wallace's works. Still we have just begun to heed the fact that the broader physiology of the future must include the biological economy of organisms as well as the functional economy of organs. I repeat *the biological economy of organisms* must become an integral part of physiology, not only in theory, but in practice as well.

The activities and inter-relations of *organisms* bear the same relation to their morphology, as do the functions and correlations of *organs* to their anatomy. The former activities differ from the latter only in degree, just as an organism differs from an organ only as a composite differs from a simple. As the morphology of organisms includes organology, so the physiology of organisms embraces the functions of organs. As the one covers all organic forms from the most minute and simple up to the most highly differentiated and complex, so the other covers all vital phenomena, whether manifested in the smallest particle of living protoplasm, in a cell, a special tissue, an organ, an organism, a species, or any group of organisms. Form and function are always the two aspects, inseparably linked together throughout the entire organic world.

The work of the physiologist runs perfectly parallel with that of the morphologist, and wherever the one divides there the other divides, and for precisely similar reasons. We have the morphology of adult individuals, likewise the physiology; we have the morphology of the developing individual (ontogeny), likewise embryological physiology ("physiontogeny"); then we have the morphology of the species (phylogeny), and along side the physiology, or the phylogeny of functions ("physiophyly," Haeckel).

*Metaphysiosis*[2] is as old and as universal as metamorphosis, and to attempt to explain functions as we find them to-day without considering their historical development, is in many cases at least, as idle as trying to account for the specified forms

[2]This word suggests itself so readily, that it will hardly be recognized as novel; it is at least self-defining.

of existing organisms without the aid of their genealogy. Monumental failures of this kind might be cited on both sides; but it may be said that morphologists have almost universally abandoned this standpoint, while physiologists have quite generally adhered to it. It is the one-sided anthropocentric development of physiology that has retarded its progress, and that still waits to be corrected. Presumptuous as such statements may appear, coming from a morphologist, they are nevertheless true and must be declared so long as the malady of one of the twin branches of biology remains as the affliction of the other. So long as such fundamental functions of organisms as heredity, variation, adaptation, are neglected by physiologists, so long will physiology have to bear the reproach of having some of its more inviting fields pre-occupied and developed by morphologists.

What processes of life are more universal or more fundamental than those exhibited in and about the dividing nucleus? What function of living protoplasm has more to tell us about how the organism comes into existence and how the foundation is laid for the development of all the higher functions, than that of cleavage? What phenomenon of life stands more in need of a physiological explanation than that of sex differentiation? What question has a more direct practical bearing on the education and development of the human race than that of the transmission of acquired characters? What functions of more transcendent interest than those of the various sense organs? Where could a more beautiful example of the evolution of function be found than is furnished in our special senses? How intensely interesting the subject of the derivation of such functions! Will the physiologist, or his protègè the psychologist, give a share of attention to these important matters, or must the morphologist not only find the problem but work it out whenever it falls within the range of evolution? That would mean working under all the disadvantages attending the separation of two co-ordinate branches which are complemental one to the other. Morphology would lose its natural helpmate, and physiology would forsake its best guide. Morphology analyses the

organic machine and thus lays the foundation for understanding its physiological use; physiology puts the suggestions of morphology to the test of experiment, and elucidates the dynamical side of the machine. What the machine consists of and what it can do, go together to make up a full concept of its structure and its functions. But the concurrence of the two sciences does not stop here. Morphology raises the question, how came the organic mechanism into existence? Has it had a history, reaching its present state of perfection through a long series of gradations, the first term of which was a relatively simple stage? The embryological history is traced out and the paleontological records are searched until the evidence from both sources establishes the fact, that the organ or organism under study is but the summation of modifications and elaborations of a relatively simple primordial. This point settled, physiology is called upon to complete the story. Have the functions remained the same throughout the series, or have they undergone a series of modifications, differentiations, and improvements more or less parallel with the morphological series? To answer this question, physiology has to appeal to the same sources of evidence as does morphology, namely, paleontology and embryology.

The paleontolgical series of forms cannot of course be experimented with; but form and function are so correlated that the latter may often be inferred from the former, and *vice versa*. The embryological series, often including free larval stages, furnishes one of the grandest fields for experimental study. Here the physiologist has an opportunity not only to study by experiment but also by direct observation and inference, and thus to join hands with the morphologist both in methods and results.

We are compelled to recognize different *orders* of individualities,—as the cell, the tissue, the organ, the organism, the corm—and of course every order must have its physiology as well as its morphology. Morphology and physiology are co-extensive, each claiming the whole organic world—as it was, as it is, and as it becomes. So long as we contradistinguish form and function, we must abide by the logic of defini-

tion. We cannot reduce the circumference of the animate world, however many radii and concentric circles we draw around our specialties. We may limit the province but not the realm. If we limit our study to man, we do not annihilate his relations to the rest of the animate world. Human physiology and human morphology represent only the latest terms of series stretching back to remote initial terms. The complexities of structure and function of the later terms we can never hope to understand until, through the study of a sufficient number of mean terms, we are able to determine the initial ones.

Three general series, each more or less incomplete, are accessible to study: (1) The systematic series, consisting of adult organisms, (2) the paleontological series, and (3) the developmental series. Morphology approaches these series by *comparative* study, and seeks to make each contribute as complete a story as possible. The same sources and the same method are open to physiology. The importance of the comparative method in physiology and the intimate co-relationship of physiology with morphology are well exemplified in a charming little treatise by Metschnikoff on "*La Pathologie Comparée de l'Inflammation*"—a work that must be reckoned as one of the fairest gems that adorn the annals of the Pasteur Institute. This monumental work shows how medicine itself must take its lessons from *comparative biology*, and approach its work from the standpoint of evolution.

The history of morphology and physiology is one continuous illustration of their inter-dependence. When the famous Harvey was asked what led him to think of the circulation of the blood he at once referred the original suggestion to one of the morphological features of the vascular apparatus—the valves and their arrangement. The hint furnished by structure was then followed up and tested by experiment, and the result was a discovery that brought the position of valves, pulsation of the heart, effects of ligatures, and other facts into rational relation to one another.

The history of theories of generation furnishes a capital example of how physiological speculation has been guided, checked, and corrected by morphological discovery. The old

doctrine of preformation, or pre-existence of organisms in the germ, and the notion of the inclusion of one germ preformation within another, was certainly strongly suggested by the unfolding of plant buds and by the metamorphoses of insects; but as soon as it became possible to examine more minutely the phases of development, it was found that the fine-spun theories of Bonnet and Haller were refuted by morphological facts, and the doctrine of epigenesis, defended by Aristotle and Harvey, was led to triumph through the observations of Caspar Friedrich Wolff.

Our special senses have afforded one of the most fertile fields for speculative physiology. It is needless to dwell on antiquated hypotheses of "vital spirits" residing in the nerves, of a subtle nervous humor, or "imponderable fluid" drawn from the blood and secreted by medullary matter (Cuvier). The history of the hypotheses of life, sensation and volition are largely, as Whewell has well remarked, "the story of the *failures* of physiological speculation." It is to the cultivation of the morphological sciences that physiology owes in a very large measure, its deliverance from the temptation to stray into the region of metaphysics.

As morphology furnishes the ground structure on which physiology operates, it naturally takes the place of pioneer and guide; but if permitted to wander too far in advance, it soon finds itself entangled with physiological problems with which it is not prepared to cope, and its efforts to release itself often end in sterile speculation. The workers on both sides should therefore advance abreast, in hand to hand contact. It is only in such reciprocally helpful relations that specialists can attain the highest possible individual development, and it is only when morphological and physiological experience and knowledge combine, that biology can accomplish such brilliant feats as that of Cuvier in reconstructing an extinct organism from its fragmentary remains.

The association of morphological and physiological research enlarges the field of vision on both sides, reduces the chances of useless labor, corrects false notions, stimulates inquiry, converts half views into whole views, and withal secures mutual respect.

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## RECENT LITERATURE.

**Conquest of the Vegetable World.**[1]—This volume forms one or the series *Etudes d'Histoire Générale.* The author, M. Louis Bourdeau, treats the subject under twelve different heads, classifying plants according to the use made of them by man. The introduction gives a general theory of the increase of plants, both naturally and by cultivation. Following this are successive chapters on plants used directly as food and those from which food is manufactured in the form of liquors, oils and sugars; the fodder plants and those from which extracts are made, to be used medicinally, or as perfumery; plants useful for the arts and industries, and those which subserve merely ornamental purposes. The work concludes with a chapter on the creation and preservation of artificial varieties of some types of plants.

**Report of the Minnesota Geological and Natural History Survey for the Year 1891.**[2]—This quarto publication of 344 pages comprises reports on the crystalline rocks and the oxide of manganese, by Mr. N. H. Wilson; the Mesabi iron range, by H. V. Winchell; a record of field observations in four granite areas, with a catalogue of rock specimens, by Mr. U. S. Grant; a sketch of the costal topography of the north side of Lake Superior, with special reference to the abandoned strands of Lake Warren, by Mr. A. C. Lawson; a composite paper on the Diatomaceae of Minnesota Inter-glacial peat; and the usual lists of additions to the Museum and library.

The iron-ore interests have developed so rapidly that the Survey has found it incumbent to pay close attention to the geographic distribution of the rocks carrying this ore, and to the questions relating to their geology. Hence the more important papers in this report are the ones bearing upon those subjects.

**The Vertebrate Paleontology of the Llano Estacado.**[3]—This report embraces the determination of the species, from the most available parts of the skeleton, of the vertebrata found by the party

[1] Conquête du Monde Vegetal. Par Louis Bourdeau, Paris, 1893. M. Felix Alcan, Editeur.

[2] The Geological and Natural History Survey of Minnesota. The Twentieth Annual Report, for the year 1891, Minneapolis, 1893.

[3] A Preliminary Report, by E. D. Cope. From the fourth Annual Report of the Geological Survey of Texas (1892); published July 1st, 1893.

of the Geological Survey of Texas of 1892, which explored the eastern border of the Staked Plain from the Texas Pacific R. R. on the south to the Denver and Fort Worth road on the north. The party was under the direction of Mr. Wm. F. Cummins, who was accompanied by Professor Cope. They examined exposures of the beds of the Trias, and of Cenozoic beds of the terranes Loup Fork, Blanco and Equus, together with a bed between the Loup Fork and Blanco. The number of species obtained from each of these horizons is as follows: Trias, 7; Loup Fork, 17; Blanco, 16; Equus, 10; bed between Loup Fork and Blanco, 8; total, 58. Of these, eleven were not regarded as determinable. Of the forty-seven species determined, the following were first discovered by the explorations of the geological survey; Trias, 4; Loup Fork, 3; intercalated bed, 3; Blanco, 14; Equus, 5: total, 29. Among the results we find the following. The establishment of a peculiar species of *Episcoposaurus* from the Trias. The discovery of a Tetrabelodon, not previously known to be of Loup Fork age, allied to the *T. serridens*. The determination of the range of variation of the dentition of the *Protohippus placidus*, and the determination of the temporary dentition of Protohippus and Hippotherium. The more important results obtained from the bed intercalated above the Loup Fork is the finding of a new species of Protohippus, Hippidium, and Equus, each; the last named allied to the *E. minutus*; the discovery of new genera of Mustelidae and Hyaenidae from the Blanco bed; the rehabilitation of the *Tetrabelodon shepardii* Leidy hitherto known from a single molar tooth; the species being found to resemble in some respects the genus Dinotherium. Also the determination of three other mastodons from the Blanco bed, and of a large new species of camel of the genus Pliauchenia; the discovery of a true horse (*Equus minutus* Cope) not larger than a sheep. The Equus bed yielded a huge Mylodon, represented by fragments only, four species of horses, and three of camels of the genus Holomeniscus, two of the last named being new to science.

Twenty-three plates illustrate the report, which add much to its value, although little can be said in favor of their artistic merits, as they are printed on ordinary paper.

# General Notes.

## GEOLOGY AND PALEONTOLOGY.

**Recent Volcanic Eruptions in California.**—In a paper published in *The Independent*, Professor G. Frederick Wright makes the following remarks concerning recent volcanic eruptions in California:

"The absence in America of volcanic phenomena east of the Rocky Mountains is amply compensated for by their abundance west of them. Probably the largest lava fields in the world are situated in Idaho, Washington, Oregon, California and Nevada. In age these belong to the latest of the geological periods, being for the most part tertiary. For many reasons there is much interest in determining how near down to the present time these volcanic eruptions have continued.

"The traveler over the lava beds of the Pacific slope cannot fail to be impressed by the fresh appearance of the basalt which covers so large a part of the surface. Considerable areas can readily be found whose surface looks as fresh as that of the slag from the furnace of yesterday. Many reports have been set in circulation by travelers that some of the volcanic cones have been witnessed by them in active eruption. Thus the members of Astor's party who, in 1811, crossed the Teton Mountains just south of the Yellowstone Park, averred that they saw peaks to the north of them sending forth volcanic smoke and vapor. As they were men of large experience, some men of science have been inclined to give credence to their opinion, and are confirmed in this view by the fresh appearance of some of the craters in the vicinity of Mount Jefferson, on the shores of Henry's Lake; while the activity of the geysers in the Yellowstone Park is perhaps indicative of the continued activity of volcanic forces throughout that general region.

"But there are so many phenomena that may be mistaken for volcanic smoke and vapor when seen from a distance that it is safer not to credit such general statements. Clouds and drifting snow might easily deceive a distant observer. It is probably thus that the reports originated concerning the volcanic activity of Mount Hood during the middle of this century. Mount Hood is indeed a volcanic crater; but so far from being active it is now filled with snow. Mount Rainier, or Tacoma, presents, however, the double phenomena of blowing hot and cold at the same time. The upper 5,000 feet of its surface is almost a continuous sheet of ice, but through a small orifice in a portion of the crater which crowns the summit, volcanic steam contin-

ues to find vent, and furnishes heat for the unlucky explorer who is compelled to spend a night at that lofty elevation.

"The most definite account of what may be called an historically recent volcanic eruption of any considerable extent in the region referred to at the outset has just been published in a Bulletin of the United States Geological Survey, by Mr. J. S. Diller. The area described is in northern California, in the vicinity of Lassen Peak, about one hundred miles southeast of Mount Shasta. Lassen Peak is itself a vast volcanic cone, and the center of numerous others smaller in size and later in origin, but all of recent geological age. The Cinder Cone, which was the special subject of Mr. Diller's researches, is ten miles northeast of Lassen Peak, in the vicinity of Snag Lake. The general elevation is here a little over 6,000 feet above the sea, and his cone rises 640 feet above the lowest point of its base, having a diameter of 2,000 feet at the bottom, and 750 feet at the top, and is composed of cinders which readily yield and slide down under one's weight as he walks over them.

"This Cinder Cone belongs to the earliest part of the eruption, and, in Mr. Diller's opinion, cannot be much more than two hundred years old. At the same time with the explosive eruption that produced the Cinder Cone, an immense amount of volcanic sand was ejected and scattered about the base for a distance of eight miles in every direction. Near the base this is between six and seven feet in depth, and thins out gradually toward the margin. Some time subsequent to this explosive outburst there took place a quiet flow of basalt, which poured from the southeast side of the cone, and spread itself over the sand, covering an area about three miles long by a little over a mile in width. The edge of this flow everywhere presents a precipitous front about one hundred feet in height, and Snag Lake is formed by the dam which this basalt stream has extended across the valley into which it flowed.

"The data for determining the age of this eruption seem to be as conclusive as could be desired. Dead pine trees, with their roots in the original soil, can still be seen projecting above the volcanic sand of the first eruption, and in some instances they have been partially overwhelmed by the later eruption of basalt, and their decaying tops project from under it. But the living trees all grow upon the surface of volcanic sand, and near the base of the cone their roots are not long enough to reach the original soil. The age of the oldest of the trees found living does not exceed two hundred years, and that, doubtless, as Mr. Diller supposes, very closely marks the date of the earlier erup-

tion. Ordinarily, also, pine trees, overwhelmed as this original forest was, would not survive more than thirty years. In the conditions of this dry climate two hundred years is a long time for them to remain exposed to the air without complete decay.

"The demonstration of so much volcanic activity at so recent a date in California renders it altogether likely that other eruptions will occur in that region in process of time, and that others have occurred at no great distance in the past. Previous to the eruption of the year 79, there was no historic record that Vesuvius had been an active volcano, and at a later period—between the fourteenth and seventeenth centuries—more than three hundred years elapsed without any serious eruption. It will be a matter of surprise if the volcanic forces west of the Rocky Mountains do not yet assert themselves with greater or less vigor. These investigations of Mr. Diller, therefore, show the possibility of bringing down to a reasonably modern period the date of the remains of man which have been found under the lava in various places on the Pacific Coast.

"Even Table Mountain in California might seem to yield a modern chronology in view of one fact brought out by Mr. Diller. It has been supposed that all of the erosion of the deeper valleys about Table Mountain has been subsequent to the time when this lava stream filled up the old channel of the Stanislaus River. In the light of Mr. Diller's observations, however, it would seem possible to suppose that the Table Mountain lava flow did not always follow the lowest channels open to it, but that it may have built up for itself obstructions in front of which it might turn aside to occupy abandoned channels of the old river at a higher level. This, at any rate, was a theory which suggested itself to me a year ago, as I examined the country about ten miles above Sonora, where the Table Mountain stream of lava crosses to the left side of the present Stanislaus. That the theory suggested to my mind in reference to the Table Mountain flow might have been a fact would seem no more strange than the actual course of some of the streams of lava which Mr. Diller has traced from the Cinder Cone so carefully studied by him. He says: 'At first the main stream flowed to the southeast, but gradually turned around to the left, until its direction was slightly west of north, where, though having flowed a total distance of three miles, the cessation of its flow was not more than a mile and a half from the vent. This course was not determined by the original configuration of the land, but by the obstructions to the later streams furnished by the cooling of earlier streams.'

"In view of present activity in the discussions of the antiquity of man, I can but regard this publication of Mr. Diller as of the very highest importance as calculated to allay the fears of a certain portion of the Christian public, and to check the hasty inferences that some are likely to draw from the recent facts which have been so freely published concerning the relation of man to the lava beds of the Pacific Coast. The time has not yet come to give the full chronological significance to those facts."

**Continental Problems.**—The annual address of Mr. G. K. Gilbert, President of the Geological Society of America, consisted of a statement of six unsolved continental problems, with a discussion of each question in turn. (1) "How are Continents supported?" introduced the doctrine of Rigidity versus Isostasy, with the weight of evidence in favor of the latter doctrine. (2) "Does heat or composition determine the difference in density of the material of the earth's crust?" was discussed in connection with (3) "What caused the Continental Plateau?" in which the author spoke at length of the only hypothesis yet advanced, that of Mr. Dana, which deserves to be more fully compared with the body of modern data. (4) "Why do Continental Areas rise and fall?" is a problem for which no solution has been suggested. (5) "Are Continents Permanent?" may probably be answered in the affirmative, but the fact is not yet fully established. (6) "Do Continents Grow?" is still open to discussion, although the doctrine has been generally accepted. In the author's opinion, the greater part of the data from which continental growth has been inferred may be fictitious and misleading. (Bull. Geol. Soc. Am., Vol. IV, 1893.)

**Mineral Resources of the United States for 1891.**[1]—This volume is the eighth of a series begun in 1882. It deals with the mineral progress of the year 1891, and contains a complete statement of the mineral products of that year. The opening chapter is a summary of the quantity and value of the metallic and non-metallic products for 1891, and also contains tabular statements of the outputs from 1880 to 1891. Under the head of Iron Ores, a résumé of the progress in the manufacture of iron and steel in the United States for the past twenty years is given.

The names of the contributors of the various sections appear in connection with the subjects treated.

[1] Mineral Resources of the United States for the Calendar Year 1891. David S. Day, Chief of Division of Mining Statistics and Technology. Washington, 1893.

**Note on an Upper Devonian Fish from Canada.**—A collection of fishes made by Mr. Jex at Campbelltown and Scaumenac Bay, Canada, has been recently examined by Dr. R. H. Traquair. Among them is a fine series of *Phaneropleuron curtum* Whiteaves, which shows clearly that the short break in the dorsal fin, which Whiteaves figured, but thought might be an accidental or abnormal character, is a natural division, and that the dorsal fin is in two distinct portions. Dr. Traquair feels justified in erecting the Whiteaves species into a new genus characterized by its double dorsal fin, and proposes for it the name *Scaumenacia curta.* (Geol. Mag., June, 1893.)

**The Diatomaceæ of the Triassic (?) sandstone of New Jersey.**—When I first settled in Newark, New Jersey, twenty years ago, I went about looking at the red sandstone for Diatomaceæ in it; but did not find them. I found pieces of trunks of wood. I found carbonate, silicate and sulphide of copper and carbonate of lime and mica, and worm burrows and ripple marks but nothing else. No minute fossils like Diatomaceæ. I looked at the sandstone every now and then, reasoning that it was a fresh water sediment, most likely laid down in very shallow water, and must contain the remains of Diatomaceæ, if they existed then. I examined the sandstone at Glen Ridge, about two miles from the station at Bloomfield on the Montclair and Bloomfield branch railroad where the Glen Ridge quarry and mining company have a quarry and are mining for copper. I examined the white sandstone at Forest Hill on the Greenwood Lake railroad and the old Schuyler copper mines at Belleville. I visited the red sandstone in the cutting where the Greenwood Lake railroad came through at Arlington just above Newark on the Passaic river. The cut is deep and it shows the sandstone dipping to the northwest and also a fissure which parted the rock in a nearly north and south direction or parallel to their strike. It is about five feet wide and shows rounded pieces of trap. This strongly indicates that the trap is not far below and that heat partially metamorphosed the rocks. This is one of the few fissures in the Triassic. The shale shows worm burrows and ripple marks. This would seem to point to a later instrusion than the Triassic of the trap. I examined the shale with acids for Diatomaceæ but without success. At last in June of this year, 1893, I found a spot immediately on the Passaic river just south of the city of Passaic where L. H. Arden has a brick yard in operation. I found he mined the clay from which the brick was made close by, and I visited the clay pit and saw the clay in finely stratified layers about as thin as paper

and extending to about twelve feet upward from the rain water which had accumulated here, on the day I saw it. The clay was red or brown and rather poor and the layers looking like a heap of reddish paper with darker papers introduced every now and then. On the top of this was about two feet of red glacial gravel in the form of till and between the gravel and the clay was a pocket of yellow clay which evidently belonged to the glacial deposit which I have examined all over northern New Jersey and which forms the so-called Lacustrine, Sedimentary or Sub Peat deposits of Diatomaceæ which occur from Nova Scotia to Pennsylvania on the Atlantic coast of the United States. This stratified clay is Triassic and I examined it with considerable interest for it was formed in shallow fresh water, and contained Diatomaceæ, scarce it is true, but the first Diatomaceæ geologically speaking that have been found anywhere on the globe if we except the Diatomaceæ of the Carboniferous Coal found by Count Castracane some years ago. But the coal in which he discovered Diatomaceæ is doubtfully carboniferous. Perhaps it may be Tertiary. The Diatomaceæ I found in the Triassic clay were *Gomphonema acuminatum* and *Brebissonia lanceolata* along with straight sponge spicules. The clay was Triassic beyond a doubt for it was under the glacial clay and glacial till. What it rested upon is doubtful, Triassic sandstone most likely, for Triassic sandstone covers this part of New Jersey and no other rock is seen. It is important to note the finding of Triassic Diatomaceæ at this time and perhaps they will be seen in quantity further on. The color of the Triassic sandstone due to red iron oxide is remarkable and deserves investigation. The same color is present in the Catskill sandstone and at first they could be classed as one, but of course the fossils are different, and are very scarce in the Triassic, and rather plenty in the Catskill. It can hardly come from the magnetite on the border of the sandstone, as I. C. Russell suggests, for that, although present in New Jersey, is not always present and cannot be the cause of the red color of the Catskill sandstone. Perhaps it is present as an iron silicate, for it is more difficult to dissolve by boiling in acids than simple iron oxide.

ARTHUR M. EDWARDS, M. D.

**Do Glaciers Excavate?**—The recent critical examination of Alpine and other mountain valleys by Professor T. G. Bonney, confirms the conclusion he reached in 1874, that these valleys appear to be much older than the ice age, and to have been but little modified during the period or maximum extension of the glaciers. Mr. Bonney asserts that the erosive power of glaciers is small—quite unequal to the

work which has been ascribed to it. In this connection the author considers the difficulties presented by certain Alpine lakes in attributing them to the erosive action of glaciers. The position of such lakes as Constance, Geneva, Como, etc., and the subaqueous contours of Como and Geneva militate against the glacial erosion theory. The hypothesis offered by Mr. Bonney as an explanation of these lake basins is that originally they were eroded by ordinary agencies, and that their beds have been subsequently affected by differential movements. He instances as an example bearing out his theory the Great Lakes of North America whose origin has been so ably demonstrated by Dr. J. W. Spencer. (Geog. Journ., June, 1893.)

**Plistocene Deposits of Russia.**—Mr. S. Nikitin has given a brief account of the Quaternary deposits of Russia in a pamphlet of thirty-four large octavo pages. It is, however, merely a summary of a more detailed report which he is soon to publish. The paper closes with the following statement of the principal theses:

1. "The sub-division of the stone age into paleolithic and neolithic epochs should be preserved for European Russia, because it here coincides with the geological divisions into Pleistocene and modern, which are, in their turn, based upon paleontological data.

2. "The study of the glacial deposits of Finland and of the western region furnishes no proof of the existence of two distinct glacial epochs and an inter-glacial epoch. All the facts can be explained by the phenomena of the oscillation of the glacier at the time of its gradual, but irregular, retreat.

3. "If, however, one accepts the Swedish and Prussian theory of the sub-division of the glacial period into two epochs and an interglacial epoch, the second glaciation cannot have extended beyond the western region, in a certain part (comparatively restricted) of the Baltic region of Finland and of the government of Olonetz.

4. "The other portion of Russia subjected to glaciation, has only one morainic stage, corresponding to the deposits of the first glacial epoch of the Swedes.

5. "At the epoch of the more extended glaciation, the major part of Russia presented the aspect of a desert of ice, similar to that of Greenland, carrying no moraine upon its surface, and presenting no elevation free from ice, where forest vegetation could be preserved.

6. "The time corresponding to the interglacial epoch and the second glaciation of the Swedes, was probably, for the greater part of Russia, the epoch of the formation of the ancient lake deposits, the loess, and

the upper terraces of the rivers, which constitute the principal repository for the bones of the mammoth and other extinct mammals, which abounded here while Scandinavia and Finland were still covered by the glacier.

7. "In accordance with the composition and genesis of her Quaternary deposits, European Russia may be divided into a series of typical regions which are very characteristic, although resting upon differences which are scarcely recognizable, but which illustrate none the less the life of the immense Russian plain during the Quaternary period, and the formation of her superficial deposits.

8. "In the second portion of the glacial epoch, or of the pleistocene, the mammoth and other large mammals inhabited southern and eastern Russia in great numbers. As the glacier retreated, these animals advanced toward the north and northwest; toward the close of the pleistocene they reached Finland for a short time, and then disappeared entirely throughout the whole extent of European Russia, but probably later in the northeastern part and in Siberia.

9. "Man lived contemporaneously with the mammoth during the second part of the glacial epoch along the limits of glaciation, possessing an industry well-advanced, making use of fire among other things, but producing implements solely of naked flint. As the glacier retired, man advanced toward the north and northwest; he arrived in Finland and the Baltic region after the close of glaciation and after the disappearance of the mammoth; but man himself possessed already the more advanced culture of the neolithic age, and besides implements of trimmed flint, he knew how to make implements in polished stone, pottery, etc.

10. "European Russia shows no traces of man in the first part of the Pleistocene, or of any more ancient man." (Am. Journ. Sci., June, 1893.)

## BOTANY.

**Check-List of New North American Plants.**—The botanical publications of the Department of Agriculture at Washington are becoming year by year of more scientific value, and at the same time more useful. Botanists have come to look upon the "Contributions from the U. S. National Herbarium" as real contributions which they are glad to receive, and in which they may feel a just pride. The last number (No. 7) consists of a "Systematic and Alphabetic Index to New Species of North American Phanerogams and Pteridophytes, published in 1892," prepared by Miss Josephine A. Clark. Appearing the middle of July, it is refreshingly recent, and makes us hope that under the energetic management of Chief Coville this will be the rule with publications from his division.

The list is much like the one published last year (Sept. 20, 1892), and as then described, it is based upon the card index of new species and new combinations, made primarily for the use of the Botanical Division. Its usefulness there, suggested to Dr. Vasey its publication for the benefit of botanists throughout the country.

A marked improvement which we notice with great pleasure is the uniform decapitalization of all specific names, and the omission of the comma before the name of the author. We trust that this will hereafter be the rule in the National Herbarium.

CHARLES E. BESSEY.

**Shall we Decapitalize Specific Names?**—By the time that this is in print, the Botanical Club of the A. A. A. S. will have discussed and perhaps decided this question; but we wish here to record before this anticipated action, our conviction that it is but a question of time when decapitalization will be the rule. It is to be hoped that the Club will decide in favor of it now, but if it does not, it will but defer the matter a few years. The revulsion against the over-capitalization of DeCandolle, Gray and Watson may not now be strong enough to demand absolute decapitalization; it may be satisfied with retaining the capital initial for genitives of personal names, and possibly for old substantives. This would be a great improvement, inasmuch as it would require the decapitalization of nearly one-half of the names now capitalized in the new edition of Gray's Manual.

Of course, every one knows that grammatically the argument is a pretty strong one in favor of a partial capitalization, but something may be said on the other side, even on this ground. Primarily the specific name is a limiting or qualifying term, that is, it has an adjectival function, and as such it is properly written with the small initial letter. There should be no question as to such cases as *virginiana*, *coroliniana*, *pennsylvanica*, etc. Linne himself wrote them with the small initial letter, as also Willdenow and Sprengel. Why then should there be any hesitancy in writing *oakesiana*, *purshiana*, *kalmianum*, etc.? Even in Gray's Manual we have *sambucifolia*, *alnifolia*, *hyssopifolius*, *nepetæfolia*, and, most astonishing of all, *fossombronioides*. Why the Italian Fossombroni should be decapitalized here, it will puzzle any advocate of capitalization to explain.

Nothing is gained by capitalizing, and it requires some extra effort to remember whether to use the capital or not, while by decapitalizing we gain much in appearance of the printed page, and save appreciably in time and the effort to remember a complicated rule.

CHARLES E. BESSEY.

**The Use of Personal Names in Designating Species.**[1]— The first sentence of the thirty-second article of the Paris Code is as follows: "The specific name ought, in general, to indicate something of the appearance, the characters, the origin, the history or the properties of the species." The twenty-seventh section of the rules of nomenclature adopted in 1877 by the zoologists of the American Association for the Advancement of Science (with the advice of Dr. Gray, and other botanists) is almost identical with the foregoing: "The specific name should, in general, indicate some feature of the appearance, characters, origin, history or properties of the species." The purpose of the rule cited is, without question, to favor the adoption of names which have some real significance, and when we look over the work of the great masters in descriptive botany we see how fully they followed its spirit. In the first and third editions of Linne's "Species Plantarum" nearly all the specific names are in some degree, descriptive. One finds names as follows (pp. 118–119) *suecica*, *canadensis*, *tomentosa*, *trifoliata*, *viscosa*, *alternifolia*, *perennis*, *uniflora*, *biflora*, *umbellata*, *corymbosa*, *latifolia*, etc. If we compare Linne's practice with that of recent descriptive botanists we find a great change in the frequency with which personal names are used. In the first two hundred pages of Vol. I, of the first edition of the "Species Plantarum," including about

[1] Read before the Botanical Club of the A. A. A. S., August 21, 1893.

one thousand species, there are not to exceed seven such names, viz: *michelianus, laflingiana, halleri, matthioli, Gmeleni, monelli,* and *Osbeckii,* (notice in passing, the capitalization, which is still maintained in the third edition). Here we have less than one per cent of names derived from personal names, which is in striking contrast with what we find in recent lists.

In the list of New Species of North American Phanerogams and Pteridophytes, published in 1891, issued by the U. S. National Herbarium, *twenty-three per cent* of the specific names are derived from personal names. In the similar list for 1892 we find a little more than 18 per cent. of such names. Taking the two years together, the personal names are exactly twenty-one per cent. of the whole. Has not this thrusting forward of personal names gone entirely too far? It certainly violates every principle of good taste. Botanists may soon be properly charged by other scientific men with showing an over-eagerness to gain the petty notoriety which attaches to having one's name borne by some plant. There should be a speedy reform in this practice.

It is a proper thing to construct a euphonious name from the name of an eminent botanist, and apply it to a new genus. There is some dignity in such a procedure; but there is a great deal of difference between the dedication of a genus to a great man, and the other practice of assigning new species to every collector,—*because the collectors like it!*

CHARLES E. BESSEY.

**Botany at the Madison Meetings.**—The most notable gathering of American botanists in recent times took place in August of the present year in connection with the forty-second meeting of the American Association for the Advancement of Science, and the several affiliated societies. Especial efforts had been made to secure a large attendance, which was successful beyond the most sanguine expectations. But few of the more active of our botanists were absent, and these were unavoidably detained.

This being the first year of the existence of a separate section (G) of botany, all members of the Association watched the experiment with much interest. But when the permanent secretary announced in the closing general session that the new section had received *one-fifth* of all the papers presented to the Association, all doubts as to the ability of the botanists to maintain a separate section disappeared.

The session opened on Thursday, August 17, with the address of the Vice-President on "Evolution and Classification," the burden of which was that in the present classification, of the higher plants especially, the facts of evolution are practically ignored.

On Friday papers as follows were read:

G. F. ATKINSON, Photography as a means for recording the macroscopic characters of micro-organisms in artificial cultures. The author detailed his method of securing good photographs by means of oblique light in connection with a black card interposed between the object and the source of light.

G. F. ATKINSON, Symbiosis in the roots of Ophioglosseæ. A fungus appears to be present in the cortical tissues of the roots of all the species examined.

B. T. GALLOWAY, Observations on a rust affecting the leaves of the Jersey or Scrub Pine. This was a discussion of the structure of the normal and diseased leaves, and an account of the mode of infection by the parasite, *Coleosporium pini.*

W. J. BEAL, Prophylla of Gramineæ. Illustrated by drawings and sketches.

CHARLES R. BARNES, On the food of green plants. This was one of the most carefully written papers presented during the meetings. The author proposed a sharper separation of the operations concerned in the nutrition of plants, as follows: (1) *Photosyntax*, for the fixation of carbon by chlororphyll; (2) *Digestion* and (3) *Assimilation.* The publication of this paper will be looked for with interest.

J. CHRISTIAN BAY, A new infection needle for the study of lower plants. Illustrated by sketches and examples.

G. F. ATKINSON, Comparative study of the structure and function of the sporangia of ferns in the dispersion of spores. Illustrated by a number of large drawings.

BYRON D. HALSTED, The Solandi printing applied to botanical work. By the use of sensitive photographer's paper the author is able to obtain fine negatives directly from leaves, and from these he prints very useful photographs. Many specimens of this process were shown.

N. L. BRITTON, Present aspects of the nomenclature question. Analyzing the subject as it presents itself to-day. There are (1) the pre-Linnæans, who would go back in nomenclature to authors earlier than Linné; (2) those who would begin with the Systema Naturæ of Linné, 1735; (3) those who would begin with Linné's Genera Plantarum, 1737; and (4) those who with most botanists would begin with Linné's Species Plantarum, 1753. To these may be added (5) a few who would select a date still more recent.

T. A. WILLIAMS, Lichens of the Black Hills. Eighty-three species and varieties are known, many of which are northern and western.

J. CHRISTIAN BAY, The bibliography of American botanical literature. The author made a plea for the beginning of such work.

DOUGLAS H. CAMPBELL, Notes on the development of *Marattia douglasii*. Describing the prothallia, and suggesting a relationship with certain Hepaticæ.

On Monday papers were read as follows:

THEOBALD SMITH, Further observations on the fermentation-tube, with special reference to anærobiosis, reduction, and gas production. Illustrated by the apparatus used by the author.

JOHN G. JACK, The fructification of *Juniperus*. The author finds that the fruits of *J. virginiana* ripen the first season, while in *J. sabina* var. *procumbens* it requires two seasons, and in *J. communis*, three seasons.

S. G. WRIGHT, The minute structure and development of the motile organ in the leaf of the Red-bud. This was an anatomical and physiological paper.

ERWIN F. SMITH, Two new and distinctive diseases of Cucurbits. Describing an *Alternaria* on melons, and another on cucumbers and cantaloupes due to bacteria.

CONWAY MCMILLAN, Preliminary statement concerning botanical laboratories and instruction in American universities and colleges. This paper was considered so important that the Association requested the Commissioner of Education at Washington to print it as one of the educational bulletins. Incidentally, it appears that many colleges are still giving *as college work*, short spring term courses in Gray's "Lessons!!"

The reading of this paper resulted in the appointment of a committee consisting of Drs. Coulter, Campbell and Britton, to inquire into the teaching of botany in the secondary schools of the United States.

BYRON D. HALSTED, The shrinkage of leaves in drying. By means of photographs by the "Solandi" process, it was shown that the shrinkage is often considerable.

M. B. THOMAS, The roots of orchids.

L. H. PAMMEL, Preliminary notes on some chromogenic bacteria of the Ames flora.

B. T. GALLOWAY, Results of some recent work on rust of wheat.

J. H. PILLSBURY, On the quantitive analysis of the colors of flowers and foliage.

For want of time the four last named were read by title.

On Tuesday the following papers were read.

S. M. TRACY, Distribution of the Gramineæ in the United States. Illustrated by many maps.

N. L. BRITTON, A consideration of species based upon the theory of evolution. An attempt to formulate our present ideas of species.

ELIZABETH G. BRITTON, A revision of the genus *Physcomitrium*. Showing that while we supposed that we had half a dozen species, it appears that we have nearly or quite double that number.

W. T. SWINGLE, On *Cephaluros mycoidea* and *Phyllosiphon* sp., two parasitic algæ new to North America. These curious plants, the first of which lives upon Magnolia leaves and the latter upon the leaves of *Arisæma*, appear to be truly parasitic.

FREDERICK V. COVILLE, An analysis of the conditions affecting the distribution of plants. These were given as temperature, light, food, water and mechanique.

J. C. ARTHUR, Deviation in development due to the use of unripe seeds. As this paper will be published in full in the NATURALIST, no summary will now be attempted.

W. T. SWINGLE, The principal diseases of citrous fruits now being studied at Eustis, Fla. Illustrated by specimens of fresh material.

P. H. ROLFS, A sclerotium disease of plants. Giving details of the structure.

ELIZABETH G. BRITTON, *Ulota americana* Mitten and *Orthotrichum americanum* Beauv. The author discussed fully the question of their identity, which appears to be established.

The following were read by title for want of time:

L. H. PAMMEL, Notes on *Rœstelia pyrata*, Crossing of Cucurbits and A case of poisoning by the wild parsnip, *Cicuta maculata*, (three papers).

The Botanical Club held sessions on Friday, Monday and Tuesday. It received the report of the committee appointed last year to prepare a check list of North American phanerogams, and after much dicussion, provision was made for printing it. In this connection, Rule III of the "Rochester Code," was modified so as to allow the use of a specific name identical with the generic. The rule now reads as follows:

"In the transfer of a species to a genus other than the one under which it was first published the original specific name is to be retained."

Another important action of the club was that relating to the proposed American botanical society. A committee of ten was elected and empowered to increase its number to twenty-five, to organize such a society. The following is the committee: J. C. Arthur, G. F.

Atkinson, C. R. Barnes, C. E. Bessey, L. H. Bailey, N. L. Britton, Mrs. E. G. Britton, J. M. Coulter, F. V. Coville, D. H. Campbell, D. C. Eaton, W. G. Farlow, E. L. Greene, B. D. Halsted, Arthur Hollick, C. MacMillan, B. L. Robinson, F. L. Scribner, C. L. Sargent, J. D. Smith, Wm. Trelease, R. Thaxter, L. M. Underwood, L. F. Ward, W. P. Wilson.

Papers were read in the club, many of them of much importance.

On Saturday the Club accompanied the Association to the Dells of the Wisconsin River, and spent a day in collecting and in the enjoyment of the beautiful scenery, with much of social pleasure.

An American botanical society is now assured. The committee to effect an organization met promptly and made preliminary arrangements for a meeting next year in connection with the Association. A sub-committee consisting of Messrs Trelease, Coulter, Bailey, MacMillan and Sargent, was appointed to attend to the details of permanent organization.

The Botanical Congress which had been called by the committee appointed for the purpose, convened at 10 o'clock, A. M., August 23, with 37 members. Since, for various reasons, but few foreign botanists were able to attend, the name adopted was the "Madison Botanical Congress." Dr. E. L. Greene of California was elected President and Henri de Vilmorin of France, and L. M. Underwood of Indiana, Vice-Presidents. J. C. Arthur of Indiana, B. L. Robinson of Massachusetts, and F. V. Coville of the District of Columbia, Secretaries. C. R. Barnes of Wisconsin was elected Treasurer.

Committee reports were received, as follows:

*On the Nomenclature of Plant Diseases.* After discussion this was referred to an enlarged committee, of which Dr. B. D. Halsted of New Jersey is chairman, with instructions to report in 1894 to Section G of the American Association for the Advancement of Science.

*On the terminology of Vegetable Physiology;* suggesting greater precision in the use of terms. This was likewise referred to a committee, with Dr. J. C. Arthur of Indiana as chairman, to report to Section G in 1894.

*On the terminology of Anatomy and Morphology.* After discussion a committee of five, with Dr. D. H. Campbell of California as chairman, was appointed to report in 1894 to Section G.

*On the Nomenclature of Horticultural forms;* recommending for the present the use of Nicholson's "Dictionary of Gardening," supplemented by the "Index Kewensis," for scientific names. This report was adopted.

*On the Bibliography of North American Botany;* urging the neces-

sity of the early inauguration of bibliographic work, and suggesting rules for uniform methods of citation. The congress voted affirmatively upon the first proposition, and then referred it to a committee with Dr. C. R. Barnes of Wisconsin as chairman. The rules as to methods of citation were agreed to, and will be printed in the proceedings of the congress.

*On the terminology of Geographical Botany.* After short discussion this was referred to a committee with F. V. Coville of the District of Columbia as chairman.

Appropriate resolutions were presented and adopted regarding the death of Alphonse de Candolle, and George Vasey.

Resolutions were adopted respecting the condition of the United States National Herbarium, at present deposited in a building in Washington which from its construction and use is liable to destruction by fire, and the United States Congress was memorialized to make early provision for a fire-proof building for the preservation of this scientific treasure. The Secretary of Agriculture was respectfully requested to urge prompt action in this matter.

The thanks of the Congress were extended to Dr. Otto Kuntze for valuable printed papers presented by him for the use of the members.

On Wednesnay afternoon open invitation of the local committee of arrangements the members of the Congress took part in a botanical excursion to Lake Wingra, and after adjournment (Thursday, 5 P. M.), all enjoyed a two hours' moonlight ride upon Lake Mendota.

There is no space in this account for a full notice of the botanical papers read in the Society for the Promotion of Agricultural Science. The Secretary, Dr. Frear, communicates the following titles:

W. J. Beal. Methods of killing Couch- or Quack-Grass.
W. J. Beal. Some Grass Mixtures for lawns.
W. R. Lazenby. Sub-irrigation for Green-house and Garden.
C. E. Bessey. The Weeds of Nebraska.
B. D. Halsted. Potatoes by the direct method.
G. F. Atkinson. A new fungus disease of the Apple.
B. T. Galloway. The Macrosporium disease of potatoes.
J. C. Arthur. A new factor in improving farm crops.

These will be published in the proceedings of the Society.

The attendance of working botanists was unusually large at all the meetings in Madison. Many men whose faces are rarely seen were present, some for the first time in their lives. A few of the active botanists of the country who have usually taken part in such meetngs were missed, while on the other hand, the older members were made aware of the fact that there is a rapidly growing group of younger men who are pushing their way to the front by their good work.—Charles E. Bessey.

## ZOOLOGY.

**Classification of the Actiniæ.**—In his account[1] of the Actiniæ of the "Albatross" collections of 1887–88, Professor J. P. McMurrich gives first a historical résumé of the growth of our knowledge of the Actinians and then presents his own ideas of the limits and arrangement of the families, followed by a description of the forms collected by the "Albatross." In the historical part we notice that the separation of the Bryozoa (better Polyzoa) from the Cœlenterates is credited to Milne Edwards. We had always understood that the discovery was made by J. Vaughan Thompson in 1830.

Changing the typographical arrangement Professor McMurrich gives the following classification of the Hexactinians.

A. Tentacles arranged in cycles — ACTINIÆ.
  *a.* Column simple
    1. Tentacles cylindrical, smooth.
      * Sphincter absent or weak, entodermal.
        † Mesenteries not numerous. — Halcampidæ.
        †† Mesenteries numerous. — Antheidæ.
      ** Sphincter entodermal, tentacles deciduous. — Boloceridæ.
      *** Sphincter mesogloeal.
        † No acontia. — Paractidæ.
        †† Acontia. — Sagartidæ.
      **** Sphincter entodermal, circumscribed.
        † Acrorhagi wart-like. — Bunodidæ.
        †† Acrorhagi foliate. — Phyllactidæ.
    2. Tentacles warty or branched.
      * Tentacles simple. — Heteractidæ.
      ** Tentacles compound. — Thalassianthidæ.
    3. Tentacles reduced to stomidia. — Polyopidæ. Sicyonidæ.
  *b.* Column provided in its upper part with branched or globular processes. — Dendromelidæ.
  *c.* Free swimming forms. — Minyidæ.

B. Tentacles arranged radially — STICHODACTYLINÆ.
  *a.* Tentacles all of one form.
    1. Tentacles few, capitate — Corallimorphidæ.
    2. Tentacles numerous, cylindrical. — Discosomidæ.

[1] Proc. Nat. Mus., XV., p. 119, 1893.

3. Tentacles nodulated. Aurelianidæ.

*b.* Tentacles of two forms.

1. Marginal tentacles cylindrical; disc tentacles wart-like, branched or foliate. Rhododactidæ.

2. Marginal tentacles pinnate; disc tentacles wart-like. Phymanthidæ.

*c.* Tentacles of various forms, not cylindrical. Cryptopdendridæ.

It is a pity that the Government cannot provide good illustrations for papers like this, but like all the publications of the Fish Commission it has put up with unsatisfactory photo-cuts.

**Maioid Crabs in the National Museum.**—Miss Mary J. Rathbun continues[2] her studies of the Maioid Crabs by an account of the species of the family Maiidæ in the National Museum. She enumerates 39 species as occurring in the collection and gives a list of desiderata which includes 100 species. The new forms described are *Chionœcetes tannerii, Cœlocerus grandis, Lepteces* (n. g.) *ornatus and Hyastenus caribbœus.* The paper concludes with an extract from the as yet unpublished MSS. of the late Dr. Stimpson, a part of his final report upon the Crustacea of the Ringold and Rodgers Expedition to the North Pacific. The value of this last would have been increased by including references to the preliminary report on the same expedition published in the Proceedings of the Academy of Natural Sciences of Philadelphia for 1857.

**A New Lancelet.**[3]—Dr. E. A. Andrews regard the small lancelet which was found by the Johns Hopkins Marine Station in the Bahamas as the type of a distinct genus of Acraniata to which he has given the name *Asymmetron lucayanum.* The chief anatomical peculiarities of the form are found in the asymmetrical character of the reproductive organs, which occur on the right side of the body alone, in the absence of fin-rays from the ventral fin and in the presence of a long caudal process extending posterior to the last myotome. Dr. Andrews has also collected the literature of the various species of Amphioxus from which we learn that the following species have been described from the world.

*Branchiostoma lanceolatum:* Scandinavia, England, Mediterranean, Chesapeake Bay? Fiji Island?

*B. caribœum:* Mouth of La Plata, Brazil, St. Thomas, Jamaica,

[2] Proc. Nat. Mus., XVI, p. 63, 1893.

[3] Studies from Biol. Laby., Johns Hopkins, V, 1893.

Tampa Bay, Gulf of Mexico, Beufort, N. C.
*B. cultellum:* Australia.
*B. bassanum:* Australia.
*B. belcheri:* Australia.
*B. elongatum:* Peru.
*B. californiense:* California.
*Asymmetron lucayanum:* Bahamas.

Besides these, specimens have been reported from Japan, Ceylon, and the Bermudas. It is possible that the *B. cultellum* of the above list may prove to be a species of Asymmetron. Peters genus Epigonichthys is apparently regarded as synonymous with Branchiostoma.

**Descriptions of Four New Rodents from California.**—During the past year I have received among other mammals a considerable series of Californian rodents of the genera Sitomys, Reithrodontomys and Onychomys. In the identification of these it was found necessary to determine, if possible, the status of certain Californian forms described by Professor Baird in 1857, more especially of his *Hesperomys eremicus, H. boylii, H. gambelii* and *H. austerus.* The results of this study were necessarily incomplete, and, though far from satisfactory, some points of importance seemed sufficiently proven to warrant publication, and a paper was in preparation and nearly ready for the printer when Dr. J. A. Allen's Article on a collection of mammals from the San Pedro Martir region of Lower California came out in the Bulletin of the American Museum of Natural History.

This covered so exactly much of the same ground gone over by my own investigations in so much more exhaustive a manner and with such similar results, the original scope of this paper has been materially changed.

Among the series lately received by me from collectors in southern California there are four forms apparently undescribed. In determining the status of these I am greatly indebted to Dr. J. A. Allen for the loan of specimens from the New York Museum of Natural History, and for the critical examination of some of my own, forming the basis of this paper.

For the loan of the type specimen of *Onychomys torridus* and a large series of rodents from southern California, thanks are due to Mr. F. W. True of the National Museum, and Mr. Gerrit S. Miller, Jr., of Peterboro, New York.

1. *Sitomys major* Sp. nov. (Type No. 1202, ♂; Col. of S. N. Rhoads, Squirrel Inn, San Bernardino Co., July 1, 1893; col. by R. B. Herron).

Description.—Size large, somewhat less than largest *S. californicus*. Tail about length of head and body, stout, and scantily covered with coarse hairs; terminal pencil inappreciable. Hind feet smaller than in *californicus*. Ears large, more rounded and thinly-haired than in *californicus*. Color pale, grayish buff on upper parts, becoming brownish on rump and lacking any darker dorsal stripe. Sides, from eyes to root of tail, more buffy than upper parts, but no definite lateral stripe. Lower parts uniform grayish white, lacking buffy or plumbeous tints on throat and ventral region always present in *californicus*. A narrow, black, ring encircles each eye.

Measurements.[1]—Total length, 193.5; tail, 98.5; hind foot, 22.5. Skull—total length, 28.5; basilar length, 20.5; zygomatic breadth, 13.8; length of nasals, 10.5; interorbital constriction, 4.3.

Another specimen, a female, taken at the same date and place, has lost half the tail during life. In no other respect does she differ from the type, the length of the head and body and of the feet being the same in both.

In size, form, dentition and relative measurements the skull of *major* differs inappreciably from its near ally, *californicus*. The resemblance of *major* to Baird's description of "*Hesperomys boylii*" and its apparent affinities with *californicus* inclined me to the belief that it was his "Long-tailed Mouse," and that it should be classed a sub-species of *californicus* as *S. californicus boylii*. Dr. Allen, who has examined the type of *boylii*, and to whom I submitted the two specimens of *major* for an opinion on this question, thinks their identity very doubtful, though admitting their apparent resemblance in size and coloration; neither does he consider the relationship of *major* to *californicus* at all close. Independently of this verdict I should have hesitated to give *major* full specific rank.

I am informed that Dr. Merriam has secured a series of *Sitomys* from the type locality of *boylii* in Eldorado Co., which will enable him shortly to re-describe that species and settle a much involved question in the synonomy of this very puzzling genus.

2. *Sitomys herronii*[2] Sp. nov. (Type No. 815, ♀, Col. of S. N. Rhoads, San Bernardino Valley, Cal., March 3, 1893. col. by R. B. Herron.)

Description.—Body short and stout; ears large, very thinly and minutely haired. Tail very long and slender (one-third longer than head

[1] All measurements given in this paper are in millimeters, and were made by collector before skinning.

[2] For Mr. R. B. Herron, whose abilities as an expert and painstaking field-collector more than deserves public recognition.

and body), clothed with minute, whitish hairs, slightly darker along ridge, the annuli not concealed thereby. There is no dark ring around eyes. Upper parts uniformly buffy gray, lacking any tendency to a darker median area, the lower sides and cheeks becoming purer ochraceous buff, the root of the tail being encircled by same color. The face is grayer than rest of upper parts. Pelage very soft, long and full. Feet white, small and slender, upper half of thighs and fore-legs, buff. Lower parts soiled gray washed with buff, whitest on chin, darkest on breast and belly.

Measurements.—Total length, 200; tail, 115; hind foot, 21. Skull —total length, 24.5; basilar length, 18.5; zygomatic breadth, 12.3; length of nasals, 9.2; interorbital construction, 3.5

This species is represented by four specimens, all taken in March, April, and June, on the ranch of the gentleman whose name they bear.

They belong to the long-and-naked-tailed, large-eared group of *Sitomys* typified by *eremicus*. In colors and general proportions the nearest ally of *herronii* is probably the *S. rowleyi*[3] of Dr. Allen, from Utah. It differs therefrom according to Dr. Allen, "in slenderer feet, buffy white instead of pure white underparts, rather grayer head and naked, instead of hairy, tail." *Herronii* also differs markedly from *rowleyi* in its skull measurements when compared with those given for the latter species by Dr. Allen. The length of nasals, given as "5.5" for *rowleyi*, is probably a typographical error. I have seen no skull of *Sitomys* in which the nasals measure less than seven millimeters, and, to judge by its other dimensions, *rowleyi* must be a large species. In its average characters *herronii* comes most closely to *Sitomys eremicus* and its sub-species *fraterculus*,[4] from both of which it may readily be distinguished by its buffy tints and larger size. Cranially, it has a broader and flatter rostrum, less recurved upper incisors and relatively much longer and wider incisive foramina than *eremicus*. There is no decided variation in size and color among the *herronii* series in my possession, the type being a fair average of the lot.

3. *Onychomys ramona*[5] Sp. nov. (Type No. 823, ♀, Col. S. N. Rhoads, San Bernardino Valley, Cal., April 11, 1893, col. by R. B. Herron).

Description.—Size somewhat larger than *O. torridus*, with larger ears. Colors similar to *O. longicauda*, but with an appreciable dorsal stripe and shorter, stout tail. Skull averaging larger or as large as *O.*

[3] Bull. Am. Mus. Nat. Hist., V, 76.

[4] Mr. Miller, who describes *fraterculus* as a full species, now considers it a "dark coast form of *eremicus*."

[5] For "Ramona," "H. H." Jackson's heroine of the San Bernardino Valley.

*torridus* and of the same proportions, but with a relatively longer mandible and higher coronoid process.

Measurements.—Total length, 147; tail, 48; hind foot, 18; ear, from crown, 12.

I have examined the type of *torridus*, with which *ramona* shows closer affinities than with any other member of the genus. Making allowance for the facts the type was "skinned out of alcohol," and the skull is missing, it is easy to see that *torridus* is externally a very different looking mouse from *ramona*, being lighter and more unicolor above and lacking the bright vinaceous wash on the sides.

Adopting the cranial and superficial characters given for *torridus* by Dr. Merriam in North American Fauna, No. 2, the two are best distinguished as follows:

| *Onychomys torridus.* | *Onychomys ramona.* |
|---|---|
| 1. Above, uniform dull, tawny cinnamon. | 1. Above, grayish vinaceous buff. |
| 2. No darker dorsal stripe. | 2. Darker grayish dorsally. |
| 3. No black ring around eye. | 3. Narrow, black ring round eye. |
| 4. Tail with dark dorsal stripe reaching three-fourths its length. | 4. Tail with dark dorsal stripe, seven-eighths to nine-tenths its length. |
| 5. Average measurements:—length, 135; tail, 45; hind-foot, 20; ear, from crown, 10. | 5. Average measurements (five adults):—length, 139; tail, 48; hind-foot, 19; ear, from crown, 13. |

CRANIAL MEASUREMENTS.

| | *torridus* | *ramona* |
|---|---|---|
| Basilar length (of Hensel) | 18.5 | 19. |
| Greatest zygomatic breadth | 12.5 | 12.6 |
| " parietal " | 11.4 | 11.5 |
| Interorbital constriction | 4.2 | 5. |
| Length of nasals | 9.6 | 10. |
| Foramen-magnum to incisive foramina | 12.5 | 13.4 |
| Alveolar length of upper molar series | 3.5 | 3.8 |
| Length of mandible | 13.2 | 15. |
| Height of coronoid process from angle | 5.8 | 6.8 |

Up to the present time no Onychomys has been recorded from California that I am aware of. Dr. Merriam informs me a large series was taken there by the Death Valley Expedition, but owing to the delay in the publication of the second part of the report on the expedition this material was, of course, unavailable in the present connection.

The American Museum of Natural History has no specimens of Onychomys from California. Two winter specimens from Dulzura, San Diego Co., Cal., were loaned by Mr. Miller. They are unaccompanied by other data, or measurements, or skulls, and so were not included in the above diagnosis. They differ from the type of *ramona* in apparently smaller size and darker dorsal shade, in which respects they more closely resemble two October specimens of *ramona*. It may be remarked that this peculiar dorsal shading is also characteristic of the majority of Dulzura *Sitomys* and *Reithrodontomys* I have examined, as compared with the same species from San Bernardino Valley, but it is not sufficient to warrant special recognition in any case.

One half-grown and one young—adult specimen of *ramona* entirely lack the characteristic colors of upper parts in fully adult specimens, being of a uniform pale steel-gray above. The same striking difference, due to age, is very noticeable in a series of *Sitomys* and *Perognathus* taken in the same region.

4. *Reithrodontomys pallidus* Sp. nov. (Type No. $\frac{32889}{25063}$, ♀, Col. Amer. Mus. Nat. History, Santa Ysabel, Cal., March, 12, 1890, col. by F. Stephens).

Description.—Smaller and lighter colored than *R. longicaudus*. Colors of upper parts tawny or buffy gray, much lighter than that of *Mus musculus*. Median dorsal area darker than sides and face, the latter being washed with ochraceous, that color becoming purer on cheeks and lateral lines of belly. Belly white, with light plumbeous cast from exposed bases of hairs. Small ventral spot and space between fore-legs, tinged with buff. Chin and throat white. Tail of same relative length as *longicaudus*, but much more finely haired and annulated, and more slender and distinctly bicolor as in corresponding parts of body. Ears relatively larger than in *longicaudus*, lighter colored and with a fulvous spot at their anterior bases. Feet pure white.

Measurements.—Total length, 137; tail, 73; hind foot, 16. Skull—total length, 19.2; basilar length, 14.6; zygomatic breadth, 10.2; length of nasals, 7.1; interorbital constriction, 3.

Only one specimen of this mouse was secured at San Bernardino. Mr. Herron reports them very rare while *longicauda* seems to be abundant near its type locality about San Francisco.

Two specimens, kindly sent me by Dr. Allen, from Santa Ysabel, are evidently the same species. They are more fully adult than the San Bernardino specimen, and, like other San Diego County skins, are blacker above. Their external and cranial characters confirm their identity with mine as contrasted with *longicaudus*. Owing to the more typical character of Dr. Allen's specimens, I have chosen one of them for the type in preference to my own. Duplicates of *pallidus* from the San Bernardino Valley southward, will most probably confirm its good specific characters. Its alliance to *megalotis* is certainly more remote than with *longicaudus*. Its possible identity with *montanus* is very doubtful on geographical grounds alone, the latter being probably, as Dr. Allen indicates, an eastern Rocky Mountain form of *humilis*. Dr. Allen's *aztecus* from New Mexico differs from it in larger size, relatively much shorter tail, less buffy color, and in cranial proportions.

In external measurements *pallidus* is much shorter and smaller-bodied than *longicaudus* and has smaller feet. In skull measurements it shows the same diminution in length with greater relative zygomatic breadth and a blunter, less attenuated rostrum. The relative length of mandible to height of coronoid process above angle in *pallidus* is in the same direction. The coronoid process in *pallidus* is sharply hooked, in *longicaudus* it is bluntly recurved.

These features are shown in the following table:

BODY MEASUREMENTS.

| | *longicaudus* (4 adults) | *pallidus* (3 adults) |
|---|---|---|
| Total length | 153. | 138. |
| Length of tail vertebræ | 80. | 75. |
| " " hind foot | 18. | 16. |
| " " ear, from crown (from skin) | 10.5 | 11. |
| SKULL MEASUREMENTS. | | |
| Basilar length (of Hensel) | 15.6 | 14.6 |
| Greatest zygomatic breadth | 9.8 | 10.2 |
| Interorbital constriction | 3. | 3. |
| Length of nasals | 7.8 | 7.1 |
| Total length of skull | 20.5 | 19.2 |
| Length of mandible | 12. | 11. |
| Height of coronoid process from angle | 5.1 | 5. |

—SAMUEL N. RHOADS.

**Zoological News. Reptilia.**—Dr. Stejneger describes[4] as new *Xantusia henshawi* from San Diego Co., California. It may be distinguished from the other members of the genus by the possession of two interfrontonasals; one row of superciliaries; frontoparietals in contact; an interoccipital, and a vertical pupil.

**Birds.**—Robert Ridgway describes[5] *Odontophorus consobrinus* from Southern Mexico. It is much like *O. guttatus*, but is often darker and lacks any buff or tawny color in the crest.

**Mammals.**—J. A. Allen enumerates[6] fourteen species of Thomomys including four (*Th. monticolus, aureus, fossor,* and *toltecus* which are new.)

[4] Proc. Nat. Mus., XVI, p. 467, 1893.

[5] Proc. Nat. Mus., XVI, p. 469, 1893.

[6] Bull. Am. Mus. Nat. His., V, p. 47, 1893.

## ARCHEOLOGY AND ETHNOLOGY.[1]

**Ninth International Congress of Americanists.**—Huelva, Spain, Oct. 7–11, 1892.—The Congress was held in the Cloisters of the Convent of La Rabida at Palos. These had been restored in the style as when Columbus resided there during the preparation for his first voyage to America.

It was opened by an address of Senor Canovas del Castillo, the Premier of Spain. He sketched the history of America, showing the Monks of Rabida and the inhabitants of Palos were strong supporters of Columbus in the organization of his expedition.

The Bishop of Badajos made a speech referring to the fraternity existing between Spain and America. This was enthusiastically responded to by Senor Palma of Peru.

A grand ball was given at night to the members of the Congress by the Municipality of Huelva.

In the evening the U. S. Warship Bennington arrived at the Port of Huelva, having in tow the two Spanish Caravels Nina and Pinta. which had been built at Barcelona under the supervision of Lieut, Wm. McC. Little, acting for Mr. Wm. S. Curtis, Chief of the Bureau of American Republics, and intended to traverse the Ocean and Great Lakes and be exhibited at Chicago in 1893.

At the session of the 8th, the representative of British Guiana asked of the Spanish Government permission to search the archives of Seville for ancient documents concerning the Discovery of America. Senor Canovas del Castillo responded heartily in the affirmative.

M. Lucien Adam of France and Senor Fabic of Spain, the President of the Congress, spoke as to the best methods of Studying the American question.

Dr. Benk, a delegate from Austria, proposed the publication of a general map of America; indeed his proposition was but a part of the general one for a map of the entire world. Dr. Benk explained his proposition, which was that this map should be upon the universal scale of 1 to 1 million, or about 16 statute miles to the inch. This would require he said, about 936 sheets, of which the land might be shown on 769 sheets. Each sheet of the map up to 60° North Latitude would embrace 5° in each direction. The more northern sheets would

[1] This department is edited by Thomas Wilson, Smithsonian Institution, Washington, D. C.

embrace 10° of Longitude. It was proposed to give great attention to the physical and political characteristics and that the sea should be represented as well as the land. The rivers were to be in blue and the hills in brown. Contours to be drawn at elevations of 100, 300, 500 and 1200, and the areas enclosed therein to be tinted. The Meredian of Greenwich to be accepted for the entire map. All places in countries using the Latin alphabet to be preserved as officially spelled. Other alphabets and unwritten languages to be spelled phonetically or according to some system yet to be agreed upon. Professor Benk estimated the cost of an edition of a thousand copies which show only the land surface to be in round numbers, 1 million of dollars, and the 769 sheets, if sold at ½ dollar per sheet would produce less than 400,000 dollars, leaving the sum of 600,000 to be divided among the respective countries. The consensus of opinion was that this would be great desideratum; whether it could be accomplished or not, was in greater doubt. But Dr. Benk argued that it would be a long stride toward successful accomplishment if an international agreement could be made, by which a uniform scale could be adopted for the making of such a map. This international agreement, he says, could be agitated only before such Congresses, allowing the delegates upon their return to their respective countries to agitate the subject, and prepare either the Government or public opinion for a successful result.

There was further discussion and other papers read, some of which had no very close relations to America and very small right to appear before the Congress of Americanists.

The rest of the day was taken up by the banquet and preparation for the fetes.

The King and Queen Regent arrived on the 10th, and during that and next day the city of Huelva and the town of Palos and the Convent of La Rabida were given over to the fetes.

At the Paris Congress, objection was made to going to Huelva by Dr. Brinton, and the outcome verified the wisdom of the objection. It was a magnificent Naval Review—40 warships of various Nations—display of bunting—firing of guns—shouting, cheering, banqueting, and fetes in grand style; but as a scientific or historic Congress, it made but slight progress.

The Queen gave a reception at the Hotel Colon at which about 1,000 guests attended. The Column erected at La Rabida by the Government, at an expense of about 450,000 pesatas (francs) in commemoration of Columbus was inaugurated. These were attended by everybody. The locality was, of course, in gala dress. Guns, flags,

music, with the bright dresses of the women and clergy, the gay uniforms of the Civil, Military and Naval Authorities and Officers, with the decorations of the pavilion and throne-room in crimson velvet and magnificent tapestries, of which the Spanish government possesses so many specimens, conspired to make a brilliant and imposing scene.

The Secretary, Senor Juan Zaragossa, was most effective in securing subscribers to the Congress of whom he had over 2,000, though only about 200 were in attendance, and but few of these were constant at the meetings or gave attention to its business. As a fete, it was a grand success; as a congress, its benefits were few.

**The Exposicion Historico-Americano.**—Madrid, Spain, 1892. —The Exposition was held in a permanent building, one which was new—just completed, and is intended as the home of the National Library, the Archeological Museum, and the Galleries of Sculpture and Modern Painting. It occupies the entire square between the Paseo de Recoletos and the Calle de Serrano for two opposite sides, and upon the other, the Calles Villa Neuva and Jorge Juan. The cornerstone of this building was laid in 1866, under the reign of Isabella II, and the building was intended for the Department of the Interior. Work progressed upon it until the foundations were laid and brought to the level of the ground, when the Revolution by which Queen Isabella was dethroned, brought it to a standstill. It thus remained until 1884, when the project was again brought forward and the celebrated architect, Antonio Ruiz del Salces, presented new plans for the building as a Library and Museum.

On the 19th of January, 1887, the contract for the completion of the building was entered into with Don Juan Cruneda at the price of 10,000,000 pesatas. (A pesata is the Spanish unit coin and equal to a franc French or 20 cents American money.) Two architects were chosen, the one to represent the government, the other to represent the contractor, and they were made, jointly, superintendents of the building. Under their joint direction, the contractor performed his work. The sequel proves the wisdom of this arrangement, for the building is erected in a satisfactory manner and apparently without dispute or disagreement. It is the custom among the English and American visitors in Spain to point, with a certain degree of reproach, to the Spanish character as carrying its love of ease and good nature to such an extent as to sap their energy; and to call them in derision, the "Mañana people," because it is said they propose never to do to-day what they can put off till to-morrow. But the erection of this palace, running over a period of time since

1866, costing two million dollars, has been completed so that the contractor was able to deliver it over, a finished building, and move out of it with all his forces within less than two months from the date originally fixed by the contract. The building is in the form of a rectangle. On the longest sides, that is facing east and west (the Paseo de Recoletos and the Calle de Serrano), the building is 446 feet long. On the other sides it is 410 feet long. The principal façade and entrance is on the Paseo de Recoletos, the secondary one on the Calle de Serrano. The building is three stories—a basement and a first and second story. The basement is built of granite, the first and second stories of marble and brick. The projections in the centre and at the corners are made to break the sameness of the long stretch of smooth wall—these projections are of Spanish marble, not clear white, but grey, streaked with yellow, and slightly ornamented with engaged columns or buttresses. The style of the building is of Greek architecture, though of no definite or particular style. The windows are square without caps or other ornamentation and without stile or mullion. They are about 25 feet high and 7 feet wide, and are filled with clear plate glass allowing the utmost amount of light to pass through. The cornice is of the Greek style; the moulding is quite heavy, though in good proportion, and projects above the flat roof which it hides entirely. The building covers a superfice of 16,850 meters. There is slight decoration upon the outside of the building except at the two entrances mentioned. Owing to the lay of the land, the entrance to the principal story is much higher on the Paseo de Recoletos than upon the Calle de Serrano. This fact has been used to advantage in making the former the principal entrance with higher and broader steps, more doors and entrances, greater amount of ornament and decoration, and altogether more imposing in appearance. The approach is by three flights of steps extending the whole width of the façade, with a broad terrace between each one which is utilized by placing pedestals and statuary opposite the pillars or columns between the doors of entrance. Some of these statues are seated and some are standing. Those seated are San Isadore and Alfonso the Wise; those standing are Luis Vives, Lopez de Vega, Nobrija and Cervantes. In various places on the façades and vestibules, are placed medallions representing many of the great men of Spain. On the façade of the Calle de Serrano, the pedestal upon each side of the entering stairway is occupied by immense griffins 20 feet long and 10 feet high, with human heads and breasts, and lion and eagle claws. Outside of these on the pedestals against engaged columns, are respectively the statues of Berre-

guette and Velasquez. The palace is a magnificent building, plain, simple, in good style and good taste, solid, impressive, not over-decorated, and excellently arranged for its purpose. There are at present, housed and under its roof, three Expositions, one in each story, distinct from each other, and organized by different authorities. That in the basement is entirely Spanish, belongs to the War and Navy Department, and consists of objects furnished by these two departments. On the first or principal story, is the International Exposition Historico-Americano, in which all objects are supposed to have relations to America and belonging to a period prior to 1700. Senor Navarro-Reverter is Delegate-General. The second story contains the Exposition Historico-European. Its objects relate entirely to Europe, but principally to Spain, and have a greater or less antiquity. Padre Fita is Delegate-General. He is a Jesuit Father, a very learned man, an ardent and wise Archeologist, and of unblemished character. His good qualities were such as that when his appeal was made to the church authorities throughout Spain for the loan of their treasures, assuring them of their safety and return, he received such offers of valuable objects as to enable him to fill his entire space with the richest and most interesting.

Let us enter this building. The basement is 20 feet to the ceiling and it has 22 rooms. The first story is 27 feet to the ceiling and has 46 rooms. The second story is 30 feet to the ceiling and has 49 rooms. The principal display rooms or halls form the outside of the rectangle. On the side toward the Calle de Serrano, these halls are 45 feet wide. On the other sides of the rectangle they are but 35 feet wide. The centre of the rectangle is devoted principally to the Library. The Reading Room is in the center, is a most excellent arrangement, and is magnificently decorated. The Standards and Coats of Arms of Spain, of all the Provinces and the principal Cities are here displayed by frescoes upon the walls. Medallions of great scientists, historians, literati, form a part of the decoration. It is 95 feet square, without obstruction to the roof, from which it is lighted by sky-light. The books are to be arranged in stacks running out from this central room like the spokes of a wheel. As we enter the building from the Calle de Serrano, to visit the Exposition Americano in the principal story, a turn to the left takes us into the section occupied by the United States, 6 rooms in all. We can pass from one hall to the other half round the rectangle, and out upon the opposite side, or continue clear around to the place of entrance. The halls containing the displays of the various countries follow in this order:—Nicaragua, Guatemala and Dominican

Republic, Equador, Uruguay, Peru, Argentine Republic, the Museums of Madrid, Costa Rica, Denmark, and the Antilles, which takes us to the opposite entrance, crossing which, we begin again—Portugal, Spain, Germany, Sweden and Norway, U. S. of Colombia, Mexico—the latter occupying the same relative position upon the opposite side of the entrance from Calle de Serrano as does the United States, and occupies about the same space. The Archeological Museum of Madrid occupies interior rooms. The arrangements for light in all these rooms is admirable. There are many windows, they are on both sides of the halls, the inner ones opening upon the interior courts. These courts are without galleries or ceilings, are open to the sky and covered with glass at the same height as the roof, thus affording nearly the same opportunity for light as is given from the outside.

The total number of objects comprising the display of the United States, was as follows:—

| | |
|---|---|
| Department of Prehistoric Anthropology | 5,000 |
| Department of Ethnology | 2,200 |
| Philadelphia Exhibit, and Coins, Medals and Money from Bureau of Engraving and Printing, Mint, and U. S. National Museum | 4,000 |
| Hemenway Expedition | 3,500 |
| Iconographia Columbina | 310 |
| | 15,310 |

Not Catalogued—estimated—

| | | |
|---|---|---|
| Books | 1,000 | |
| Photographs | 1,500 | |
| Lithographs | 500 | |
| Wing Frames | 600 | |
| Maps, Pictures | 300 | |
| Agricultural Department | 100 | |
| Indian Schools | 300 | |
| Animals | 50 | 4,350 |
| Total objects, | | 19,660 |

Considered as 20,000 objects.

(*To be continued.*)

## SCIENTIFIC NEWS.

Contrary to the experience of most summer laboratories this season, the Marine Biological Laboratory at Woods Holl is filled to overflowing. Over 100 students are in attendance, this number being the greatest in the history of the institution. Those in charge report a very gratifying improvement in the ability of those attending.

Dr. H. Kelly Corning, formerly at Prag, is now to be addressed at the Anatomischer Anstalt in Basel.

Friedrich Ziegler, Freiburg i. B., has just published a new catalogue of his wax models illustrating embryological subjects. These models are real works of art, and are most valuable aids in instruction. More or less complete exhibits of them may be seen in Harvard, Johns Hopkins, Bryn Mawr, Michigan University, Chicago University, Clarke University, Cornell, Wisconsin University, Oberlin, Wellesley, Minnesota University, Boston Society of Natural History, Columbia College, Rochester University, University of Illinois, and Northwestern University. The whole collection, as far as ready for the market, includes 279 models, which are furnished for $602.84.

Dr. H. B. Ward, formerly instructor in Zoology in Michigan University, has been appointed Associate Professor of Zoology in the University of Nebraska. After Sept. 15, his address is Lincoln, Nebr. With his appointment Professor E. A. Barbour is relieved of the instruction in Zoology, and will have only that in Geology.

Dr. Zander has been appointed extraordinary professor of Anatomy in the University of Königsberg.

Mr. Edward J. Bles, formerly Fellow at Owens College, Manchester, is now Director of the Biological Station, at Plymouth, England.

Dr. Hermann von Ihering is now the Director of the Zoological Division of the Museum at Sao Paulo, Brazil.

Dr. Adelbert Seitz has been appointed Director of the Zoological Garden at Frankfurt a. M.

Henry Viallanes, Director of the Zoological Station at Arcachon, France, died the last of May, 1893, aged 36 years. He was one of the

most promising of the younger French zoologists, and had made the structure of the Arthropod nervous system a subject peculiarly his own.

J. F. M. Bigot, possibly the best known student of the Diptera, died in Paris, April 14, 1893, in his 75th year.

The death of Professor Carl Semper, on May 29, was not unexpected. For some time he had been suffering in health, and lately had done no teaching in the University of Würzburg. He is best known for his prolonged researches in the Philippine Islands, the scientific results of which have formed a splendid monument to his name. He visited the United States in 1876, and gave a course of lectures before the Lowell Institute in Boston, which later were issued in that most suggestive volume, "Animal Life as Effected by External Conditions."

Dr. Eugen Korschelt, formerly of Berlin, has been appointed Professor of Zoology in the University of Marburg.

The attempt to reduce the rate of postage upon natural history specimens sent through the mails of the postal union has failed. Such specimens can only be sent at regular letter rates (5 cents for each half ounce) except to Canada and Mexico, where the rate for such specimens is a cent an ounce. Dried animals, including insects, are excluded entirely from the mails.

Mr. James Wood-Mason died at sea on the voyage from Calcutta to London, May 6, 1893. He was born in Gloucestershire in 1846; was later connected with the Indian Museum, and at the time of his death was Professor of Comparative Anatomy in the Medical College of Bengal. He was best known for his work upon the Morphology of Arthropods, his systematic work on the Crustacea of India and his explorations of the deep waters of the Gulf of Bengal with the dredge.

The Chicago Exposition is furnishing the best opportunity for studying the external characteristics of human races that has ever been presented to Americans. There are colonies of Dahomeyans, Samoans, Egyptians, Javanese, Japanese, Esquimaux, North American Indians, Hindoos, Turks, etc. Every person interested in Ethnology should visit the Exposition.